

FIRE SAFETY, 1983

HEARING
BEFORE THE
COMMITTEE ON
LABOR AND HUMAN RESOURCES
UNITED STATES SENATE
NINETY-EIGHTH CONGRESS

FIRST SESSION

ON

EXAMINING FIRE SAFETY ISSUES, FOCUSING ON THE CAUSES OF
FIRES, AND TO WHAT EXTENT IS TOXICITY A MAJOR PROBLEM IN
FIRES

JULY 19, 1983



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FIRE SAFETY, 1983

TUESDAY, JULY 19, 1983

U.S. SENATE,
COMMITTEE ON LABOR AND HUMAN RESOURCES,
Washington, D.C.

The committee met, pursuant to notice, at 9:40 a.m., in room SD-430, Dirksen Senate Office Building, Senator Orrin G. Hatch (chairman) presiding.

Present: Senators Hatch, Quayle, Humphrey, and Randolph.

OPENING STATEMENT OF SENATOR HATCH

The CHAIRMAN. I am pleased to chair this hearing of the Senate Labor and Human Resources Committee on various issues involving fire safety. I thank the witnesses who are presenting testimony here today.

The issues to be discussed today will center on three critical questions: One, what are the causes of fires and what are the causes of injury and mortality from them? Two, how can we eliminate the causes of fires and reduce mortality and injury? Three, to what extent is toxicity a major problem in fires, and what can be done about toxicity?

Fire, as we all know, is a national problem. It is estimated that approximately 8,000 people die each year from fires in the United States and an additional 31,000 individuals are injured. Losses resulting from damage to property exceed \$6 billion annually.

Fire safety trends in the United States are somewhat encouraging. There has been a decline in the rate of fire deaths over the last 5 years. However, we have a long way to go when we compare the United States and Canada to Europe and Japan, where the deaths by fire per million population are about one-half our rate. Some believe the improvement in the United States is due to the new awareness of the general public to the fire threat, as well as the widespread use of early-warning smoke detectors in the home.

Many of the dramatic fires resulting in multiple losses of life occur in well-publicized major destructive fires, usually in hotels or institutions. However, over 80 percent of fire deaths and injuries result from fires in one- and two-family homes or apartments. Although profiles for residential fire deaths in the United States vary from State to State, it has been determined that fires associated with space heating, cooking, and cigarette smoking pose the most significant threat to residential occupants. While not ignoring institutional fires, our biggest challenge is preventing fires in our homes.

Probably the most controversial area of fire protection today is the toxicity of the products of combustion of the materials used in our buildings and furnishings, both manmade and natural. Decisions made in the development of standards, building codes, and regulations concerning toxicity of the products of combustion will have far-reaching fire safety and financial implications in the United States. Therefore, I am interested in hearing testimony on the toxicity issue and what can be done to prevent deaths from inhaling toxic smoke in fires.

In conclusion, we have called these hearings to learn from the experts how to reduce the number of fires in the United States and what aspects of fire safety should receive our greatest attention, so I am hopeful that today's witnesses will help all of us on this committee and our colleagues throughout the Senate to better understand the issues surrounding fire safety.

In that regard, I want to pay particular tribute to Senator Quayle, who has a major interest in this area and of course has been the fomenting reason behind holding these hearings. He understands that I can only be here for a short time this morning, so I have asked him to chair these hearings as soon as I have to go because of other committee hearings as well. However, I personally appreciate his interest in this area and his desire to resolve some of the great difficulties that we have. I think all members of this committee have the same feeling, and I appreciate the efforts that have been put forth.

At this point, we will turn to our distinguished Senator from West Virginia, Senator Randolph, and take his statement at this time.

**STATEMENT OF HON. JENNINGS RANDOLPH, A U.S. SENATOR
FROM THE STATE OF WEST VIRGINIA**

Senator RANDOLPH. Thank you very much, Mr. Chairman. I am delighted to join with you and with Senator Quayle and Senator Humphrey at the beginning of this very important session on a crucial subject. I join you in commendation, especially, to Senator Quayle for his understanding and his knowledge in this field.

Fire safety is a crucial subject and this hearing will be of more importance than perhaps the news stories might indicate, although I am sure we will have adequate coverage. I shall review the testimony of the witnesses, including that given by Richard Brooke, whom I know as a fellow West Virginian.

Firefighting and coal mining are two of the most hazardous occupations in our Nation. We have many persons that are engaged in both activities in West Virginia. There are approximately 46,000 miners in our State; at the present time, 12,000 of these miners are unemployed. More than 5,000 firefighters are at work in West Virginia, many of them, of course, members of volunteer fire departments.

During the period of July 1, 1981, through June 30, 1982, there were 62 deaths by fire in West Virginia, with a total estimated loss of \$105,721,000. That is the result, my colleagues and our guests, of fires totaling 9,291.

In our Mountain State we have 413 fire departments which report their statistics to the West Virginia Fire Marshal. These include salaried and volunteer firefighters. I pause for just a moment to speak of the volunteer departments in West Virginia. I cannot speak too highly of their volunteer efforts.

In my home town of Elkins our fire department has two or three salaried officials but it is the volunteers that make the fire department, with those salaried personnel, effective. Up the valley at Valley Head, 22 miles to the south, is the volunteer fire department. Mr. Chairman, it does not just respond to that fire that occurs in our county. It covers perhaps seven or eight counties in its service in time of stress, and that is true all over the hill country. The volunteer fire departments are a very valuable adjunct of what we call the highly trained, paid or salaried personnel.

These people, they are truly representative of responsible citizenry and they show it in time of need. Each department receiving State funding must have at least 10 fully trained firefighters, and of course many of our departments have more than that number. I shall insert, with the permission or agreement of the chairman, certain records, statistical data on fires in our State, and they could perhaps be placed at the conclusion of my remarks if that would be agreeable.

Yes, 62 men, women, and children lost their lives in West Virginia in 1982 in fires. It is accepted that injuries and fatalities associated with fires are a result of smoke inhalation. We must, and I know we shall, examine the nature of the gases that are released as fires burn, and fully understand the toxic effects of these fumes on humankind. We must develop strategies to better address the health hazards associated with fires and to improve fire prevention programs.

Mr. Chairman, the witnesses that you and our colleagues will hear will help us focus on the problems of fire safety. We can determine, perhaps, what additional hearings you and Mr. Quayle and others might believe would be helpful to further examine scientific and medical evidence certainly related, perhaps directly, to toxicity and to the health effects associated with smoke inhalation. These hearings may not only be desirable but required for a full treatment of this vital subject matter.

I thank you very much, Mr. Chairman.

[Material submitted for the record follows:]

WEST VIRGINIA FIRE STATISTICS

FY 82 (July 1, 1981-June 30, 1982)

Source: Office of the WV State Fire Marshal

<u>Type of Structure</u>	<u>Fires Reported</u>	<u>Estimated Loss</u>
Public Assembly buildings (more than 50 capacity)	115	\$5,260,000
Educational Facilities	38	375,000
Institutional (hospitals, nursing homes, etc.)	52	189,000
Residential (1-2 family homes, apartments, mobile homes, hotels)	3,235	63,240,000
Stores/Offices	168	12,860,000
Industrial	10	410,000
Manufacturing	65	11,950,000
Storage	294	2,650,000
Special Properties (rr, vacant)	278	2,830,000
Mobile Properties (equipment, autos)	1923	5,625,000
 Total	 9291	 \$105,721,000
Fire Deaths in West Virginia	62	

The CHAIRMAN. Thank you, Senator Randolph.
Senator Quayle.

**STATEMENT OF HON. DAN QUAYLE, A U.S. SENATOR FROM THE
STATE OF INDIANA**

Senator QUAYLE. Thank you, Mr. Chairman.

I want to thank you for agreeing to have these hearings. I think it is a very important issue for the public. I want to commend Senator Randolph on his usual, profound, and exact statement on the issue. I know of his concern for it, and look forward to working with him in these hearings.

I believe that this issue of fire safety is of great importance. It has been recently demonstrated in the major fires we have had, whether hotel fires, plane fires, fires in jails, that this issue grabs the public attention, and that is one of the reasons we are responding today. It is a public concern. It is a public policy issue, and anytime there is public policy issue then obviously there needs to be a determination on what the role and the function of the Congress should be.

Death and injury resulting from fire represents a significant health problem for this Nation. As we conduct this hearing today 20 persons will die in fires somewhere in the United States. Eight thousand Americans perish as a result of fire, and another 250,000 persons are injured each year. These statistics reflect a rate of mortality and morbidity five times greater than experienced in European countries.

We compete with Canada, unfortunately, for the worst fire safety track record among the developed nations. That is not a very good statistic and it is something that we need to bring to the forefront. We need to examine the issue and determine what we should be doing about it.

Again, I want to express my appreciation to the chairman for his understanding and interest in this issue. I would ask unanimous consent, so that we can get along with the hearing and listen to the witnesses which we are here to hear, to have my entire opening statement inserted in the record.

I will just conclude that one of the issues that will come up deals with the issue of toxicity and the existence of new toxicants, I believe, prompts several questions: Whether newer combustible products are significantly more toxic than those already in use; whether these materials give off their toxic products at such a rapid rate as to reduce significantly the chances that occupants will escape; whether the current state of the art in fire hazard assessment enables the appropriate measure of these factors; and what, if anything, the results of this measurement implies for those on the State and local level responsible for setting fire codes.

Finally, Mr. Chairman, I hope that our discussions will lead to further cooperation between government at all levels, the firefighting, research, and safety communities, and private industry. I believe that only through the joint efforts of these bodies can we better inform the public about the dangers of fire, advanced firefighting and fire prevention technology, and make reasonable

public policy concerning the combustible materials found in our homes and our workplaces.

I hope that this attitude and this cooperative effort will be forthcoming from our witnesses. I think that this is hopefully a beginning of something that will be beneficial not only to the members of this committee, because they will be more informed, but beneficial to the public and to those particular groups that are interested in fire safety, fire prevention, and what we can do about a very alarming statistic and where, on a comparative basis, the United States has a very, very poor fire safety track record.

[The prepared statement of Senator Quayle follows:]

Senator Dan Quayle

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FOR IMMEDIATE RELEASE
July 19, 1983

CONTACT: Larry Smith

WASHINGTON, D.C.--U.S. Senator Dan Quayle (R-Ind.) requested a hearing on fire safety by the Senate Labor and Human Resources Committee for Tuesday, July 19.

"Each year fires in the United States kill 8,000 people and injure another 250,000," said Senator Quayle. "This is five times the rate for European countries and the highest in the world."

These figures, and concern expressed by firefighters across the country, have prompted Senator Quayle to lead this Senate investigation.

"Eighty percent of fire deaths in this country are caused by toxic fumes, not flames," Quayle stated. In the MGM Grand Hotel fire in Las Vegas, sixty-four of the 84 victims were 25 floors from any flames.

"We need to determine where these toxins are coming from," Quayle said.

A fire in a Biloxi, Mississippi jail in November, 1982 killed 27. Although the fire was limited to one cell, it was believed that toxic smoke from burning polyurethane cell padding spread throughout the prison's ventilation system. Five years earlier smoke from burning polyurethane was blamed for 49 deaths in a Tennessee prison.

The CHAIRMAN. Thank you, Senator Quayle.

Senator Humphrey.

Senator HUMPHREY. I have no opening statement.

The CHAIRMAN. Thank you, Senator Humphrey.

Our first panel consists of representatives of three organizations with critical roles in reducing fires, and I hope each of them will address the key questions before us which are, one, what are the causes of fires and the causes of mortality and injury from them; two, what are recommendations for eliminating the causes of fires and reducing mortality and injury; and, three, to what extent is toxicity a major problem in fires and what can be done about toxicity?

Therefore, I am pleased to introduce our witnesses at this time and welcome them before the committee. Our first speaker will be Mr. Fred J. Villella, who is the Associate Director of Training and Fire Programs at the Federal Emergency Management Agency. Accompanying Mr. Villella is Mr. Ed Wall, the Acting Director of the U.S. Fire Administration.

Our second speaker is Mr. John C. Gerard, who is the Washington representative for the National Fire Protection Association.

Our third speaker is Mr. Donald Flinn, general manager of the International Fire Chiefs Association.

I would like to welcome all of you here with us today, and I will just mention that all witnesses have been told to limit their remarks to no more than 6 minutes. The yellow light will go on with 1 minute to go, and then the red light will mean that the time is expended and we will cut you off at the end of 6 minutes. We would appreciate it. It will move our hearings along and, I think, be in the best interest of everybody.

We also, of course, want to allow enough time for questions so that we can get into these matters as much as possible.

At this point we will insert the prepared statement of Senators Pell and Hawkins.

[The statements referred to follow:]

STATEMENT BY SENATOR PELL AT LABOR COMMITTEE HEARING ON
FIRE SAFETY: JULY 19, 1983

Thank you, Mr. Chairman, for holding this hearing on a subject of immense importance for firefighters and for any citizen subject to the risk of fire.

Of the 8,000 deaths that are caused every year in the United States by fire, a large percentage are actually due to inhalation of toxic gases. The types of materials that contribute to these gases, and their relative levels of toxicity, are still matters of subject and debate. In this regard, I would like to insert in the hearing record a helpful letter that I have received from Mr. John V. Lipe, the Vice President and Technical Director of the Royal Electric Division of International Telephone and Telegraph in Pawtucket, Rhode Island.

Mr. Lipe's letter notes that plastic-insulated wire and cable may have received an undue and deceptive share of the blame for toxic gases, and he therefore calls for a uniformly applied set of requirements that are measured by a single universally used test method. Mr. Lipe's comments, and his call for joint industry-government action to develop such requirements, are thoughtful and helpful additions to today's testimony. I hope that his words and his spirit of cooperation can assist in forming a comprehensive solution to the problem of toxic gases in fires.

If there is no objection, Mr. Chairman, I ask that Mr. Lipe's letter appear in the hearing record following my statement.

JUN 15 1983

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
ROYAL ELECTRIC DIVISION
PAWTUCKET, RHODE ISLAND 02862

JOHN V. LIPE
VICE PRESIDENT AND TECHNICAL DIRECTOR

June 10, 1983

The Honorable Claiborne Pell
United States Senate
Russell Senate Office Building
Room SR 335
Washington, D. C. 20510

Dear Senator Pell:

It has come to my attention that Senate Labor and Human Resources Committee will shortly be holding hearings on general fire safety, U.S. fire-fighter morbidity and toxicity. It is to the latter subject that I address this letter.

There is no question but what the issue of toxicity is of grave importance as it relates to the burning of building materials. Unfortunately, there is no easy answer to this problem. It is also unfortunate that plastic insulated wire and cable has been singled out as being a primary source of toxic fumes. Many untrue and unfair allegations have been promulgated by advocates of metal tube and conduit in their "battle" with the plastic conduit industry and this together with the allegations arising out of some of the major hotel fires have painted insulated wire and cable with too wide a brush.

It is true that PVC insulated wire generates toxic fumes but so do most, if not all, of the contents of a building that burns. The wire and cable industry should do its part to help minimize this problem and, in fact, the major standards making groups, such as, the Insulated Cable Engineers Association and Underwriters' Laboratories, have active working groups studying this problem.

My concern is that our industry, of which a major portion is centered in Rhode Island, will become the victim of the hysteria that is currently prevalent. I urge you to call for a fair and well-balanced action by your committee as you develop a position on this issue. What is really needed is a uniformly applied set of requirements that are measured by a single universally used test method. The current fractioned approach where each state or regulating body develops its own test method and its own requirements can only continue the chaos that exists today.

The National Bureau of Standards has done substantial work in this area. The Office of Management and Budget has moved to encourage and support the use of the voluntary standards system. I would urge your committee to seriously consider a joint government-industry action group to develop the requirements by which the effects of toxicity are measured.

Respectfully yours,


J. V. Lipe
Vice President and
Technical Director

JVL/ak

STATEMENT OF SENATOR HAWKINS
ON
FIRE SAFETY

Mr. Chairman, the hazards of fire and toxic fumes pose a substantial threat to property and life. Most of us are aware of the devastation wrought by flames but the injuries and deaths caused by toxic fumes go largely unnoticed. In the past few years, toxic fumes have contributed to some of the most tragic fires in this country. At the Las Vegas MGM Grand Hotel, as firefighters battled the blaze on the ground floor, toxic fumes took their toll. Twenty stories above the fire, guests perished from this silent killer. In much the same manner, many died at the Beverly Hills Supper Club in Cincinnati. In all, 165 people were killed in these two tragedies, many not from flames but from the far more lethal killer, toxic fumes.

The threat of toxic fire is not limited to buildings. Just last month, as an Air Canada jet neared Cincinnati, plastic trays, seats and cushions, all common in airplanes, smoldered into a holocaust of fumes which claimed 23 victims. An event some five years ago in my own home town of Orlando highlights the type of tragedy brought about by this type of material. Five years ago, a pregnant woman and her three children died in a blaze ignited by a foam cushion. The autopsy showed they were overcome by toxic fumes. Orlando firefighters still speak of that tragedy, the outline of the four bodies etched in soot on the uncharred floor, and they still speak of the ever present dangers of toxic fumes.

Each year the national fire protection association estimates that fire kills more than 7,000 Americans. It leaves 30,000 more crippled or maimed, and it destroys \$6 billion worth of property in this country every year.

The toll that fires takes on our American society is a horrible one, and even more horrible when we know full well that most fires can be prevented. However, knowing that most fires are preventable and actually preventing them are very different positions.

Until we can find a way to make Americans more safety-conscious, we must rely on making our surroundings safer and more resistant to fire. To that end, America has an extensive network of fire and safety codes at the federal, state and local levels. Despite this profusion of regulations, American still has more fires and a higher death rate from fire than any other developed nation in the world.

We must look at ways to halt this tragic situation, and one of the first questions we should ask is whether today's fire codes have kept pace with the increased use of synthetics and plastics in recent years. The question is central to the issue because more than 80% of the deaths caused by fire are the result of inhaling toxic smoke or gas. It is true that this nation's firefighters have become proficient in dealing with toxic gases and have made impressive advances in the use of respiratory equipment while fighting fires. Unfortunately, the occupants of burning buildings do not have the same access to this protective breathing equipment. These helpless victims often are killed by toxic fumes before firefighters can reach them.

In view of the ever increasing reliance on synthetic material in the construction industry, we must now determine (1) how and whether this trend should be reflected in our federal and state fire regulations, (2) whether our building practices contribute to this nation's higher death rate from fire, and (3) how we can best protect the safety and lives not only of the American public at large, but also of the dedicated firefighters who lay their lives on the lines every time they are called to the scene of a fire.

The CHAIRMAN. Mr. Villella, would you begin?

Senator RANDOLPH. Mr. Chairman, might I suggest that the witnesses identify themselves now?

The CHAIRMAN. That would be fine.

Senator RANDOLPH. It would be helpful to us.

The CHAIRMAN. Why don't we go from your left to right.

Mr. FLINN. I am Donald Flinn, general manager, International Association of Fire Chiefs.

Mr. GERARD. I am John Gerard, Washington representative for the National Fire Protection Association.

Mr. VILLELLA. I am Mr. Villella from the Federal Emergency Management Agency, and the Associate Director for Training and Fire Programs. I represent both the director of the agency and this administration. My position is appointed by the President with the advice and consent of the Senate. I mention this, Mr. Chairman and Senators, to give you the emphasis that this administration places on this issue of public fire safety.

The CHAIRMAN. Thank you. Would you introduce your colleagues who are with you?

Mr. VILLELLA. I am joined by Mr. Wall, who presently is in charge of the U.S. Fire Administration, which also is a position appointed by the President with the advice and consent of the Senate; and by Mr. Donovan, who is the superintendent of the National Fire Academy, a position also appointed by the President.

The CHAIRMAN. Well, we are happy to have both of you here as well.

Mr. Villella, we will turn to you.

STATEMENT OF FRED J. VILLELLA, ASSOCIATE DIRECTOR, TRAINING AND FIRE PROGRAMS, FEDERAL EMERGENCY MANAGEMENT AGENCY, ACCOMPANIED BY ED WALL, ACTING ADMINISTRATOR, U.S. FIRE ADMINISTRATION, AND MR. DONOVAN, SUPERINTENDENT, NATIONAL FIRE ACADEMY

Mr. VILLELLA. Thank you very much, Mr. Chairman.

I would like to echo the comments and compliments to Senator Quayle and members of this committee for having the courage to address before the public an issue of great substance to the American people; safety in their homes.

I would like to briefly review my statement for the committee. I would like to explain what we have been doing and indicate how we have identified the nature of the fire safety problem in America.

FEMA is encouraged by the interest in fire safety shown by this committee. Regardless of the progress that has been made in reducing the tragic losses from fire, most people in the United States are not conscious of the related and tremendous economic losses.

While Government and industry have worked hard to bring about a substantial decline in fire death rates, over 100,000 American households still suffer the loss and trauma of a dwelling fire each year. The total cost of fire, when one includes the costs of municipal fire departments, insurance overhead, building construction, and other features, exceeds \$21 billion in this Nation per year.

The Federal Emergency Management Agency, through the U.S. Fire Administration, was given a mandate by Congress to help reduce these losses in the Fire Prevention and Control Act of 1974. We are pleased to report there has been a statistically significant reduction. We believe that these reductions are a reflection, to some degree, of the relatively new Federal fire focus.

We have achieved breakthroughs in quick-acting sprinkler systems, smoke detection and fire protection systems, firefighter health safety, and arson awareness and prevention. Local fire service leadership has been enhanced by three years, now, of operations of the National Fire Academy at the site at Emmitsburg, Md.

It seems that each year a new popular fire protection issue comes to the forefront: arson, self-extinguishing cigarettes, among others. This year, after the tragic hotel and jail fire deaths from toxic fire off-gases, the issue appears to be fire gas toxicity from burning synthetics. We recognize this is a problem that needs to be addressed. We also realize that toxic smoke problems are created by the burning of natural as well as synthetic substances.

Eighty percent of all fire deaths occur in homes. Regardless of whether plastics are included in the fuels involved, between 85 and 95 percent of all fire fatalities and injuries result from the inhalation of or exposure to toxic gases in smoke, not from thermal injury. We acknowledge this, and are approaching the problem of fire toxicity in several practical ways.

We have completed cooperative agreements with members of the medical profession to develop and promulgate a standard medical protocol. We also believe it is impractical in the short term for the Federal Government to suggest the alteration of the constituency of the materials that are used to construct and furnish today's homes. If it is required, this will come about through the existing consensus on fire code and standard-setting.

FEMA, through the U.S. Fire Administration, is concentrating on the prevention of fires as well as detection and extinguishment in the early phases of fire development. Mr. Chairman, I believe the widespread application of automatic sprinkler systems coupled with approved detection systems is a giant step forward in significantly reducing the toxic fire gas problem.

FEMA's efforts, through the development of more sensitive and quicker-acting sprinkler heads, promotion of cost-effective retrofit sprinkler installation in existing buildings, and the development of coordinated residential sprinkler and detection systems can go a long way toward reducing the tragic losses from toxic gas inhalation. This appears to be an increasingly practical and a potentially achievable alternative.

It is important, nonetheless, to remember that the fire problem in the United States is much broader than the issue of combustion product toxicity. The Nation's fire service, with the support of Government, can reduce the causes of fire ignition and spread while educating the public in fire prevention and how to react when a fire does occur. We are addressing the direct causal factors of fire loss.

Further, if we help to improve a fire department's ability to manage a fire emergency once it occurs, through training and more

effective firefighting tools, we are able to reduce the degree of loss when a fire does get started. To protect one of the most likely to be injured and killed in fires—the American firefighter—we must offer better health and safety protection. These are areas where FEMA is addressing the fire safety issue.

Given the immutables of, one, the unacceptably high number of residential fire deaths and, two, the acknowledged facts regarding smoke inhalation injury, it is our collective judgment that these two areas should be the targets of major fire reduction efforts for FEMA with the active support of the industry.

Years ago, before either the Fire Administration or FEMA existed, most fire departments had independently developed their own method of recording fire data. We have made substantial progress, with participation by members of the industry and fire departments throughout the Nation, in improving the quality of the reporting of fire incidents.

Arson continues to affect the economy of many American communities. The arson problem has been addressed successfully by collective efforts on several fronts. These efforts include training and the development of advanced technological systems like the Arson Information Management System [AIMS] which is now being prototyped in seven cities across this country. AIMS provides fire departments at the community level more detailed, substantive data on the nature of their arson and fire safety problem. Juveniles are also involved in the arson problem, and we are addressing that problem through a proactive system.

The ability of local communities to upgrade their level of fire service management in the face of tight budgets will continue to improve as the National Fire Academy training effort, through the National Emergency Training Center, increases its range of courses and numbers of graduates.

I would like to complete my testimony, Mr. Chairman, by sharing a few reflections on the role of research and the partnership of the fire services with private industry, which have been major factors in the development of solutions to the fire problem. Recently a major corporation dedicated substantial resources to develop a new fire-resistant fiber. This type of laudable private sector assistance can have favorable impact for the future. These efforts should be commended by all concerned. Also, work with the private sector has further resulted in recent major breakthroughs in sprinkler technology and automatic remote residential alarm systems. As noted earlier, quick-reacting sprinkler heads have been developed, and our knowledge of the spread of residential fires has improved to the point that low-cost residential sprinklers are now more practically available. Research and development programs initiated and managed by FEMA have resulted in a new industry consensus standard for residential sprinkler systems. The Federal Government-industry partnership for the improvement of life safety in the fire environment is illustrative of how we can best work to solve many of our major fire problems.

Until now I have primarily addressed the civilian fire death problem. However, firefighters themselves are too frequently injured in fires. These men and women who courageously respond daily to save lives and property have among the highest death and

injury rates for any peacetime occupation. To help reduce this toll, FEMA and the U.S. Fire Administration are working with industry and other Government agencies to develop improved firefighter protective equipment, and we are in the final evaluation stages of a new revolutionary firefighter turn-out gear. In addition, we have been working to develop a more efficient and lightweight breathing apparatus for both firefighters and miners.

Mr. Chairman, when listing representative programs where we are working to combat the fire problem in America, it is difficult to decide what to include and what to leave out. What I have attempted to provide you with today is a sense of our priorities and the direction in which FEMA is taking. In the interests of time, I will simply conclude this prepared statement by saying that we are entering upon an exciting new era of joint Government-industry sector cooperation to reduce our Nation's appalling fire losses.

Mr. Chairman, we will be delighted to answer any questions.

[The prepared statement and responses of Mr. Villella to questions submitted by Senator Hatch follow:]

Statement by Fred J. Villella, Associate Director

Training and Fire Programs

Federal Emergency Management Agency

Before the

Committee on Labor and Human Resources

United States Senate

July 19, 1983

Mr. Chairman, and members of the Committee, I am pleased to appear before you to discuss the Federal Emergency Management Agency's views on the fire problem in the United States, what we are doing about it, and what remains to be done.

We are strengthened and encouraged by the interest in fire safety that has been shown by members of this Committee. Regardless of the progress which has been made in reducing the tragic losses from fire, most people in the United States are unaware of the enormity of the human and economic losses caused by fire each year. About 7,000 people are killed; thousands are injured, and \$5 billion worth of property is destroyed by fire each year. Incidentally, fire fatalities have been reduced significantly from the 10,000 or more reported a mere decade ago. While government and industry have worked hard to bring about this decline in fire death rates, over 100,000 American households still

suffer the loss and trauma of a dwelling fire each year. The total cost of fire, when one includes the cost of municipal fire departments, insurance overhead, and building construction features required by codes, added to the direct and indirect losses, amounts to over \$21 billion per year.

The United States, along with Canada, has the highest per capita fire death rate of all major industrial nations. While fire protection and control is a state and local responsibility, the Federal Emergency Management Agency, through the United States Fire Administration, was given a mandate by Congress to help reduce these losses in the Fire Prevention and Control Act of 1974. We are pleased to report that the fire problem has been significantly reduced. We believe that these reductions are a reflection, to some degree, a reflection of the relatively new federal fire focus. We have achieved breakthroughs in quick acting sprinkler systems, smoke detection and fire protection systems, firefighter health and safety and in arson awareness and prevention. Local fire service leadership has been enhanced by three years of operation of the National Fire Academy in Emmitsburg, Maryland, as well as by the extension and strengthening of networks for public fire prevention education, and local and regional task forces to combat arson.

It seems that each year a new popular fire protection issue comes to the forefront, be it arson or self-extinguishing cigarettes. This year, after the tragic hotel and jail fire deaths from toxic fire off-gases, the issue appears to be fire gas toxicity from burning synthetics. We recognize this as a problem that needs to be addressed. We also realize that the toxic smoke problem is created by the burning of natural as well as synthetic substances. Regardless of whether plastics are included in the fuels involved, between 85 and 95 percent of all fire fatalities and injuries result from the inhalation of or exposure to toxic gases in smoke, not from thermal injury. We acknowledge this and are approaching the problem of fire toxicity in several practical ways. We have completed negotiations with the American College of Emergency Physicians, to provide them with a grant to develop and promulgate a standard protocol for the evaluation and treatment of smoke inhalation injuries. We also believe that it is impractical, in the short term, for the Federal Government to try to alter the constituency of the materials used to construct and furnish today's buildings. This, if it is required, will come about through existing consensus fire code and standard setting mechanisms that are already in place. FEMA, through the U.S. Fire Administration, is concentrating on the prevention of fires, as well as the detection and extinguishment in the

early phases of fire development. Frankly, Mr. Chairman, I believe the wide-spread application of automatic sprinkler systems, coupled with approved detection systems, would be a giant step forward in eliminating, or at least significantly reducing, the toxic fire gas problem. FEMA's efforts, through the development of more sensitive and quicker-acting sprinkler heads, promotion of cost-effective retrofit sprinkler installation in existing buildings and the development of coordinated residential sprinkler and detection systems.... can go a very long way towards reducing the tragic losses from toxic gas inhalation. This appears to be a practical and achievable alternative.

It is important, nonetheless, to remember that the fire problem in the United States is much broader than the issue of combustion product toxicity. If we, the Nation's fire service, supported by government, can reduce the causes of fire ignition and spread, while educating the public in fire prevention and how to react when a fire does occur, we are attacking the direct causal factors of fire loss. Further, if we help to improve a fire department's ability to manage a fire emergency once it occurs, through training and more effective firefighting tools, we are able to reduce the degree of loss when a fire does get started. To protect

those most likely to be injured and killed in fires - the American firefighter - we must offer better health and safety protection. These, ...all of these, are areas where FEMA is attacking the fire problem.

Given the immutables of: one, the unacceptably high number of residential fire deaths and; and two, the acknowledged facts regarding smoke inhalation injury, it is our collective judgement that these two areas should be targets of major fire reduction efforts for FEMA in the foreseeable future.

Now that I've told you a little of the scope of the fire problem and where we intend to put added emphasis, please allow me a few minutes to point out a some of what we have done and are currently doing. Rather than speak in generalities about all of our fire loss reduction programs, I'd like to highlight some of the more representative ones.

Eight years ago, before either the U.S. Fire Administration or FEMA existed, most fire departments had independently developed their own method of recording fire data, and one could not compatibly collect and use information from different parts of the country. To solve this problem, the National Fire Incident Reporting System (NFIRS), which is a voluntary network of state and local governments collecting

a core of fire loss information, was started within the USFA. This system has grown from an initial six states in 1976 to 37 states plus the District of Columbia today, including 8,000 participating local communities. We are now working to compare the fire data gathered by NFIRS with that sampled by the National Fire Protection Association, so that fire service program planners are provided with a continuing measure of how our programs are impacting on fire losses. It is from this data that we can determine that heating is the leading cause of fires in residences, having passed cooking several years ago; and that in terms of deaths and injuries, smoking remains the leading cause, especially smoking associated with drinking. NFIRS allows appropriate targeting of programs to people in each setting, rather than a broad brush approach.

Early application of NFIRS data indicated that if you had a smoke detector you were only 1/2 as likely to die if you had a fire. An independent study, commissioned by FEMA this last year, shows that there has been a substantial increase in the number of households with detectors since 1980. Nearly 67% of all homes are now equipped with smoke detectors. This is a result of a combined FEMA/industry campaign. In the next few years I hope to put an equal level of effort into making affordable residential sprinkler systems available to all households.

Arson continues to destroy the economy in many American communities. The arson problem has been addressed successfully on several fronts. Our National Fire Academy has trained hundreds in fire and arson investigation. The U. S. Fire Administration continues to support local and regional arson task forces. To help combat arson for profit the USFA is continuing to assist cities to develop local Arson Information Management Systems (AIMS) which identify buildings likely to be targets for arson. This information is then used for both prevention and prosecution. Through the use of federally supplied computer hardware and software, designed for a specific community, the level of arson prevention and prosecution is greatly enhanced.

Over 50 percent of all arrests for arson are juveniles. We are continuing to develop and provide materials for fire department screening and counseling of juvenile fire setters. New this year are; programs to address rural arson problem and the use of satellite teleconferencing as a national arson training tool.

The ability of local communities to improve their level of fire service management in the face of tight budgets will continue to improve as the National Fire Academy, an arm of the National Emergency Training Center, increases its range

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of courses and the number of graduates. One of our newest additions is the Microcomputer Laboratory, which is utilized in the course "Use of Microcomputers For Fire Service Management," as well as in four other management level courses. During FY '82, 4,123 students, fire officers from every State in the Union, had completed over 8,387 student weeks of classes.

Much of fire suppression coverage in the United States is provided by the nearly 900,000 volunteer firefighters. To get needed training into the field for those who cannot afford the time away from other careers to come to the National Emergency Training Center, we have an expanded, training-outreach program. Last year greater than 10,000 students attend field training programs, delivered at 228 sites across the country, with a greater outreach schedule planned for next year.

I would like to complete my testimony by sharing a few reflections on the roles of research and the partnership with private industry, which has been a major factor in the development of solutions to the fire problem. For example, one major corporation has recently committed \$50 million to build a plant to manufacture a new fire-resistive fiber. These fibers will be used in the manufacture of firefighter protective clothing and other firesafe textile applications.

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It is this type of laudable private sector assistance that we are trying to nurture for the future. Also, our work with the private sector has resulted in major breakthroughs in sprinkler technology in the past two years. As I noted earlier, quick-reacting sprinkler heads have been developed, and our knowledge of the spread of residential fires has improved to the point that low cost, residential sprinklers are now available. Research and development programs, initiated and managed by FEMA, have resulted in a new industry consensus standard for residential sprinkler systems ((NFPA 13D)). This FEMA - Industry partnership, for the improvement of life safety in the fire environment, is illustrative of how we can best work to solve most of our major fire problems. Another promising technology is automatic remote residential alarm systems, where smoke detectors are connected directly to a central alarm bureau by the telephone or TV cable.

Until now, I have primarily addressed the civilian fire problem. However, firefighters themselves are more often injured in fires than civilians. These men and women, who charge into buildings that others run out of, have among the very highest death and injury rates for any peacetime occupation. To help reduce this toll, FEMA/USFA has teamed with industry and other government agencies, such as NASA and the Bureau of Mines, to develop improved firefighter

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protective equipment and are in the final evaluation phases of a new and revolutionary firefighter's turn-out gear. Also, we have been working on a project to develop a more efficient and light-weight breathing apparatus for both firefighters and miners.

In listing representative programs where we are working to combat the fire problem in America, it is difficult to decide what to include and what to leave out. What we have done; is to attempt to provide you with a sense of our priorities and the direction that we are taking. In the interest of time, I'll simply conclude this prepared statement by saying that we are entering upon an exciting new era of joint government and industry sector cooperation to reduce our Nation's appalling fire losses.

Thank you, Mr. Chairman. I would be pleased to answer any questions that the Committee might have.

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Federal Emergency Management Agency

National Emergency Training Center
Emmitsburg, Maryland 21727

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Honorable Orrin G. Hatch
United States Senate
Washington, D.C. 20510

Dear Senator Hatch:

This is a reply to your letter of July 26, 1983, which contained six questions.

Question 1: What are the three things that could be done that would most reduce deaths by fire?

Answer:

Three things that could be done that would most reduce deaths by fire:

- A. Installation of residential sprinkler systems, both in existing and new buildings.
- B. Intensification of effort to foster the installation of smoke detectors. Stress also must be placed on:
 - 1) Maintenance and testing of detectors on a regular basis.
 - 2) Public Education on proper response to detector alarms.
- C. An effective national program to increase public awareness to the hazards of fire in the home.

Question 2: Can you explain what is being done to protect the public from toxic combustion products in buildings?

Answer:

Present efforts to protect the public from toxic combustion products in buildings are mainly reactive. Except for the installation of sprinklers and prompt evacuation of occupants at the first manifestation of a fire, little has been done in this area. Prompt, proper and adequate ventilation of the fire building by firefighting personnel should reduce the risk of death from inhalation of toxic combustion products, but the best efforts cannot be guaranteed effective.

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Many factors serve to increase the risk of death from this cause. Among these are the proliferation of hi-rise construction, more tightly sealed buildings to increase energy efficiency, and the quantum jump in the use of plastics in furniture, interior finishes, floor covering, and clothing. Also contributing is the expanding use of central air conditioning, which spreads the toxic products to many points remote from the fire itself.

Question 3: Do you feel combustion-toxicity criteria should be included in major building codes (why not?)

Answer:

At the present time an accurate acceptable combustion-toxicity criteria does not exist. New York State is in the process of compiling a limited listing of toxicity ratings of various materials. We are monitoring the scope of and the acceptability of this project. I would be supportive of inclusion of such criteria when it becomes the state of the art.

As you well know, the building codes do not govern the contents of a building. If the best building is filled with contents capable of emitting highly toxic off gases during pyrolysis or active flaming combustion, the death threat is obvious.

Question 4: Has FEMA addressed the issue of relative toxicity among combustible materials?

Answer:

The Federal Emergency Management Agency (FEMA) has addressed the issue of toxicity among combustion materials in the following programs:

- A. The United States Fire Administration (USFA), through the Firefighters Health and Safety Division, has developed advanced equipment for structural fire-fighting. One requirement for such equipment is that it not cause harm to the wearer should he or she be in a situation where the equipment might ignite. Consequently, the off-gases of the various materials which make up the ensemble were characterized and measured.

- B. The United States Fire Administration has undertaken two major studies (Boston and San Antonio) to characterize the environments of working fires. Among the characteristics examined are gas components and concentrations.
- C. In the testing of residential sprinklers, one of the benefits we seek to measure and document, is the sprinkler systems ability to suppress gas generation by activating at an early stage in the fire.
- D. The United States Fire Administration, in conjunction with the Center for Fire Research and the National Fire Protection Association, performs investigations of major life loss fires. In these investigations, toxicity is examined as one element which may have contributed to the tragedy.

Question 5: How do you suggest we go about informing the public of the dangers of fires in order to reduce the number of deaths and injury from fires?

Answer:

The development of an effective public fire education effort should be established on two fronts. The first level should be nationwide mass media programs to educate the public as to fire safety messages and the importance of fire safety. These efforts should be targeted toward children, adults and elderly citizens. Each of these categories have required a specific type of message that is appropriate for the problem experienced by that group.

The second level should include the provision of public fire education assistance to the communities through cooperative programs between the Governor's office and FEMA. The delivery of public fire education at the local level is normally carried out by a division of the individual fire departments. An effective public fire education program would not only involve the fire department, but those voluntary community organizations that deal directly with citizen groups, and the private sector. A coordinated approach involving interested local civic groups would undoubtedly have a major impact on reducing fire deaths and injuries. The provision of federal support in the form of technical assistance, transferable model programs, of training for public fire education, and the research and development of new methods and approaches for public fire education would have the most positive effect in reducing fire related life loss.

The Federal Emergency Management Agency, through the offices of the U.S. Fire Administration and the National Fire Academy, have on-going public fire education programs that provide direct public fire education messages and also provide for the development of public fire education programs for use by local fire service organizations. Some of the current programs include:

Resident and Field

Public Fire Education Courses through the National Fire Academy.

Sesame Street Fire Safety Program

National Program to educate pre-school children using local community organizations and also military installations.

Juvenile Fire Setter Counseling Program

Learn Not To Burn Program

A public fire education program for school children in cooperation with the NFPA.

Nationwide Public Fire Education Conference.

Kerosene Heater Public Safety Announcements

Public Education Assistance to many states.

Question 6: What new information or tools might be needed to help in assessing risks in fires?

Answer:

Under the heading of new information or new tools needed to help in assessing risks in fires, I suggest the following:

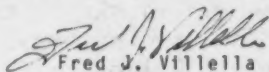
- A. As mentioned above, I think that combustion-toxicity criteria should be developed, not only for building materials and geometry or use, but also for building contents.
- B. One of our current projects at the USFA is the development of an emergency room protocol for victims of smoke and toxic gases. Part of this study will deal with the toxicology of off-gases from various materials or combinations thereof. The results of

- this project will not only increase victim survival rates, but will give added insight into the toxicity of various materials under fire conditions.
- C. The application of systems analysis to the assessment of fire risk in buildings, with the objective of not only assessing the risk, but indicating how best to assure the safety of the occupants.
 - D. Expansion of the National Fire Incidence Reporting System (NFIRS) for the purpose of assessing the efficacy of certain measures as well as delineating deficiencies and conditions requiring remedial action. This expansion will also help to outline training needs as well as operational procedures and precautions to be observed.
 - E. An operational system with exciting possibilities is a command vehicle with a television monitor and recorder. Part of the system consists of four portable TV cameras. With these, it is possible to transmit a video account of conditions at various sectors of a large scale operation. Thus, for example, the incident commander can see at the TV monitor the conditions visible from the rear, without ever leaving the command post. Also, the TV transmissions can be taped for post-fire critique and also for training. Part of the on-board equipment would be a micro-computer with appropriate software to assist the on-scene commander in assessing various hazardous materials and other fire incidents.
 - F. While not a new concept, I recommend expansion of the current efforts of local fire departments in the field of fire prevention. A large part of this can be accomplished by on-duty operational personnel who are on emergency call by radio. One obvious benefit of this mode of inspection is that the operating forces know the buildings in their district and the attendant risks associated therewith. In many departments, buildings are inspected by one division and fire operations are conducted by an entirely different division.
 - G. Continual efforts are being made to enhance the public's ability to assess fire risks in buildings in which they work, reside, or otherwise visit. A salient part of this effort is educating the public in proper behavior if they learn of, or suspect, a fire condition.
 - H. Expansion of the Arson Information Management System will also serve to assess the risk potential of buildings and structures in areas indicated to be arson prone. This predictive method is being refined for use in rural areas, where arson is recognized as a problem.

- I. Enhanced utilization of master planning will serve to assess the fire risk of an entire community. This risk includes not only conflagration potentials, but also vulnerability to unplanned hazardous materials events, earthquakes, and other man-made or natural disasters.
- J. Finally, more widespread use of ADP systems in risk assessment is vital. A municipality's data bank must include information needed by incident commanders for safe and efficient operations. Examples include potentially dangerous conditions in buildings or structures themselves; hazardous contents, including their properties, and operational considerations.

Senator, I trust that the above answers your questions. If you need further information or amplification on any of the above points, please let me know.

Sincerely,



Fred J. Villella
Associate Director for
Training and Fire Programs

The CHAIRMAN. Thank you, Mr. Villella.

I will just state at the beginning of these hearings that all of your statements in full will be entered into the record, as though fully delivered.

Mr. Gerard.

**STATEMENT OF JOHN C. GERARD, WASHINGTON
REPRESENTATIVE, NATIONAL FIRE PROTECTION ASSOCIATION**

Mr. GERARD. Thank you, Mr. Chairman, members of the committee.

I am John Gerard. For 30 years before I came to Washington I was a member of the Los Angeles Fire Department. The last 5 years I was the fire chief in Los Angeles. For the past year I have worked for the National Fire Protection Association.

I am not sure that you know just who we are, NFPA. We are a nonprofit, technical, educational membership organization. We were founded in 1896. We have been the principal advocate of fire safety in the United States from that time forward. Our membership is drawn from all the disciplines that are involved in fire protection.

There is no single interest group that is dominant in the NFPA. We are not a trade nor an industry association. The only common denominator in our membership is a concern about fire safety. In addition, NFPA's sources of income are so diverse that no single interest group can influence our policies or our codes and standards.

I had intended to go over the fire problem, but Senator Hatch covered that very adequately with his statistics. I thought you did an excellent job of identifying statistically what the problem is. Mr. Villella enhanced it a little bit.

There is one point I think is important to emphasize and reemphasize. That is that when a fire starts in this country, it is most likely going to start in a residence. When a fire fatality occurs, that too is most likely to occur in a residence. The most likely cause of that fatal fire will be a cigarette. The most likely cause of a fire that is not fatal would be a heating appliance or cooking, but I think that we need to identify and reidentify because the single biggest problem, it appears to us, in dealing with the fire problem is the almost invincible apathy of the American people toward fire. We must continue to strive to develop a sense of personal responsibility toward fire.

Fire frequency, fire mortality, fire injuries, all of these are decreasing. Even for firefighters in the past years we have seen a decrease in fire fatalities. However, I think it is important to identify just how many firefighters die. In the past year there were 49 career firefighters and 68 volunteers. More volunteers die in fires than career firefighters; I think that is an important issue that we need to address.

Mr. Villella pointed out that fire statistics are trending downward, as did you, Mr. Chairman. The aggressive increase in the use of smoke detectors has played a large role in reducing these losses, and it is a fine example of public and private cooperation. The Federal Emergency Management Agency and the U.S. Fire Administration have been very active in supporting both the testing and the development of improved smoke detectors and sprinkler systems. They have also been very active in helping to support public education efforts. We feel one of the most effective public education efforts in the United States is the NFPA's "Learn Not To Burn" program, which reaches 25,000 classrooms and millions of families every year with a message of fire safety.

Finally, one of the reasons for the improving fire statistics is the effective application of codes, good, comprehensive codes and standards in communities across the country. We are building a safer environment. Where we live is safer. But what can we do for the future, because the picture certainly is not good? It is still a very bleak picture, even though there have been some small improvements over the past several years.

One of the things we need to do is to continue those programs that are already in place, that are successful: Public education; increasing detector use; increasing research and development in toxicity and hazard assessment. As we develop technology, we must figure out ways to apply that technology.

Technology application means more than just developing a fast-response sprinkler head. It means developing a better understanding of the materials that we are using in the built environment. Materials for construction and furnishings must be reasonably safe for the use to which they are put, and we have seen over the past years some materials that were not reasonably safe. Research leading to improved fire performance of products and materials must be encouraged; it must be supported; and if necessary it must be mandated. Manmade products can be improved; manmade products must be improved.

Finally, we need to acknowledge that one of the most active and highest interest areas of fire safety today, as has been identified by

each of the speakers, is combustion toxicity. We know that all fires produce toxic gases. It has been known for decades that the presence of carbon monoxide in smoke is responsible for the majority of fire deaths. A research project on fire gases initiated by the NFPA 43 years ago led to the first fire code provisions to prevent the spread of smoke and toxic gases.

The more recent advent of synthetic materials in both the structure and the contents of buildings has raised many questions as to whether the toxicity hazard has changed. It is not yet clear whether the products of combustion now contain significant amounts of new toxic gases that could render a person unable to respond to danger even before those gases reach lethal levels. Suggestions have been made that such incapacitation is a possibility, and that persons who might otherwise survive do not.

Our toxicity committee has at this point concluded that the present test methods for toxicity of the products of combustion are really inadequate for regulatory purposes; that test methodologies are in a state of development; further research is required before there is one that is suitable for use in materials screening; and, finally, present toxicity test methodologies cannot and should not be used by themselves for hazard assessment.

In conclusion, I would like to emphasize six points: One, while the statistics of fire are moving downward, the United States is a long way from adequate safety from fire. Second, fire safety education must be expanded and intensified to make the public aware of fire, its effects, and solutions that are already known to work. Third, there must be a further increase in the use of smoke detectors and sprinklers in the American home.

Fourth, fire safety codes and standards must be adopted and properly applied in all jurisdictions. Fifth, the development and application of practical and applied research must be increased in the fight against fire. Finally, and I think one of the really crucial issues for your committee to evaluate, is that we must be wary of premature action that surely will dissipate the leadership energy and waste valuable research resources. The fire problem in America is far too serious to risk that.

Thank you, Mr. Chairman.

[Material supplied for the record follows:]

NATIONAL FIRE PROTECTION ASSOCIATION

1. CAN YOU EXPLAIN IN MORE DETAIL WHAT NFPA'S "LEARN NOT TO BURN" PROGRAM INVOLVES? HOW EFFECTIVE HAS THIS PROGRAM BEEN IN EDUCATING CHILDREN?

Learn Not to Burn is a comprehensive firesafety education program developed by the National Fire Protection Association as a means of reducing fire deaths, injuries and property loss. The program has grown to include a national media campaign, an elementary school curriculum and an extensive outreach effort. Learn Not to Burn teaches positive, practical behaviors. Some of these focus on protection -- what to do if a fire starts; others teach the step to take to prevent fires from occurring. The primary goal is to teach people of all ages and abilities the proper actions to take.

Over the years, Learn Not to Burn has been credited with saving at least 138 lives from fire. These "saves" come from all over the world and are the result of both the television messages in the national media campaign and lessons learned in school through the Learn Not to Burn Curriculum. People of all ages have been spared death or injury from fire, and in many cases, children have saved their own lives or those of a friend or parent. A complete listing of the Learn Not to Burn life saves is included in this report. (See Attachment II)

Learn Not to Burn is the result of an intense national survey conducted on behalf of the Association to determine how to reach the public with firesafety information in the most effective manner. The survey determined that a national advertising campaign using both television and radio would help to accomplish the objectives of the program. The study further indicated that firesafety messages should be clear, appealing and helpful. Above all, they should reflect NFPA's commitment to teaching positive firesafety behaviors.

Learn Not to Burn television efforts utilize the talents of Dick Van Dyke, the well-known American actor who communicates firesafety messages credibly and naturally. A series of 30-second television spots was produced and distributed to stations across the country by the Public Service Council. A radio campaign was also developed, using well-known athletes to convey important life-saving messages.

Other radio campaigns were targeted for specific audiences. These include the inner city audience as well as American Indians who lived on reservations. Both of these campaigns recognized the special fire problems of each population.

The results of these media efforts have been both positive and encouraging. Viewer and listener reaction has offered praise, citing the timeliness and helpfulness of the messages. More dramatically, NFPA files contain documented incidents of the life saves that have resulted from the Learn Not to Burn program. (See Attachment III)

During the past few years, the Learn Not to Burn program has continued to grow, its efforts and programs expanding in a number of ways. Television spots are added regularly to the existing ones and are distributed on a

regular basis to stations across the country. To help the fire service support the television spots, NFPA produces and distributes media campaign kits (See Attachment IV). These kits are distributed free of charge to allow a fire department to conduct a media "blitz" -- a brief, but intensive campaign that promotes the single, positive firesafety behavior targeted in the television message. Each kit offers newspaper and radio public service announcements, as well as print materials and implementation instructions. With release timed to coincide with the distribution of the appropriate television spot, the media campaign kit enables a fire department to coordinate print, radio and television messages to blanket a community with firesafety information.

NFPA has also concentrated its resources on reaching youngsters in schools. The guiding philosophy is the same: to provide a firesafety curriculum that helps classroom teachers convey positive messages that children can remember throughout their lives. The result of several years of development, testing and evaluation was the Learn Not to Burn Curriculum. Separate levels of the Curriculum are geared to different groups of students by grade level. Lesson plans and suggested activities allow a teacher to integrate firesafety lessons with more traditional classroom subjects.

The Curriculum is used in classrooms across the country with more than 27,000 units now in the hands of teachers. Learn Not to Burn provides the community with a meaningful way to focus on firesafety, and benefits residents in a number of ways. The lessons learned by children in school are brought into the home environment, and in some instances have made the difference that resulted in saving someone from serious injury. Children have learned to be responsible for themselves as well as their family members. In addition, the program fosters positive attitudes concerning firesafety so that today's children will grow into adulthood with a sensitivity to fire and a knowledge about fire protection and prevention. (See Attachment V)

The Learn Not to Burn program has also expanded in a more personal way -- through a program of outreach. The outreach relies on the work of NFPA's Learn Not to Burn Regional Representatives, each of whom represents a particular section of the United States. Experienced firesafety educators, they work with fire service personnel, educators, government representatives and individuals to assist with local firesafety efforts. They provide technical assistance to communities wishing to adopt the Learn Not to Burn Program.

Each August the Association brings together the Regional Representatives with firesafety educators from across the country for the annual Learn Not to Burn Conference. The training and motivation provided at the Conference allows the participants to gain new perspectives on firesafety education and ways of planning and implementing programs. (See Attachment I)

The growth and success of the Learn Not to Burn programs reflect NFPA's serious commitment to firesafety education as a mean to combat our nation's fire problem.

2. HOW IS NFPA DEALING WITH THE ISSUE THAT ONLY ONE-THIRD OF THE HOMES IN AMERICA ARE UNPROTECTED BY SMOKE DETECTORS? WHAT TYPE OF PROGRAMS IS NFPA WORKING ON TO DEAL WITH THIS PRESSING ISSUE?

In addition to the on-going Learn Not to Burn efforts, the NFPA conducts many targeted educational and promotional programs, all devoted to improving fire safety in America. Currently, one of our targeted programs focuses on increased detector use in those homes not presently protected by smoke detectors. This is a three phase program covering a three-year period. Phase 1 of the Smoke Detector Firesafety Program is a development phase in which a written smoke detector program implementation manual will be produced for local fire department and community use.

Phase 2 of the program is a test phase in which the manual, developed in Phase 1, will be tested in selected cities. The smoke detector program manual will be evaluated by personnel from these cities and the NFPA will revise the manual accordingly. Phase 3 of the program is a dissemination phase in which 80 cities and urban counties across the United States will be selected to implement the strategies and procedures of the smoke detector program as presented in the manual. We anticipate that Phase 2 will begin early in calendar 1984.

3. HOW DOES NFPA THINK MAN-MADE PRODUCTS CAN BE IMPROVED? WHAT TYPE OF RESEARCH MUST BE DONE TO ACHIEVE THESE IMPROVEMENTS?

It is the firm conviction of NFPA that any product made by man can be improved. There is no such thing as absolute perfection in-so-far as mankind is concerned. To achieve improvements industry must direct a larger share of their research dollars into developing improved product performance. This type of research is already going on in several companies, but it must be spread throughout the industry and expand within individual companies.

One type of research deals with sprinkler and smoke detector performance and the costs for providing this protection. There is a need for research into improving the fire performance of synthetic fibers and materials. Other improvements in synthetic materials must be in the area of improved ignition resistance, reduced flame spread, better control over heat release and smoke generation rates and finally - better understanding of and control over the contribution to toxicity in the fire environment. In short, the fire community needs research leading to comprehensive improvement in the fire performance of synthetic materials of all kinds.

4. WHY DOES NFPA BELIEVE THAT PRESENT TOXICITY TEST METHODOLOGIES CANNOT/SHOULD NOT BE USED BY THEMSELVES FOR FIRE HAZARD ASSESSMENT?

Basic requirements of toxicity tests needed for code and standard preparation are that the test be: 1) quantitative and reproducible, 2) practical, in terms of cost and equipment, 3) capable of providing the concentration versus

exposure time relationship which determines the physiological effects, the fundamental measure of toxicity for inhaled agents, and 4) capable of producing results that can be interpreted for application to a real fire. Requirement No. 4 is especially important.

The NFPA Toxicity Committee surveyed over 20 different tests, and all fell short of providing the basic requirements stated above. The NFPA does not believe that toxicity tests alone can be used to judge hazards associated with materials, nor to compare or rank materials in this respect. Other material performance characteristics and parameters of the overall system in which the materials are found must be considered in making a meaningful hazard assessment. The NFPA therefore, does not consider it appropriate to recommend a specific hazard assessment technique at this time. Because the subject is exceedingly complex, and because many judgmental factors will be involved, such recommendation should be the result of intensive study by the special NFPA Committee constituted specifically for that purpose. The actions of this committee should be promulgated only after extensive public review and comment so that the practical consequences as well as the technical merits of its recommendations are fully explored.

5. HOW DO YOU SUGGEST WE BETTER EDUCATE THE GENERAL PUBLIC ON FIRE SAFETY?

Firesafety education has been recognized as the key to long term effective fire prevention efforts in helping to reduce the number of fire deaths and the amount of property damage each year. The Learn Not to Burn program has successfully demonstrated this.

During the past ten years, firesafety education efforts have become more instructional in nature with particular emphasis on targeting messages for specific audiences and giving people information using a positive, behavioral approach. Arming people with information rather than scaring or reproaching them has met with success in the firesafety education community.

Recently, NFPA has been utilizing a "single focus" approach to teach firesafety by using all media to stress a single message of life saving importance. By saturating the community with the same message in a variety of ways and in a number of formats, people see and remember the message. The Learn Not to Burn media campaign kits help communities develop and implement this single focus approach.

NFPA feels that firesafety education efforts in this country could be strengthened by reinforcing the role of the professional firesafety educator. Firesafety educators have a network of communication established to exchange ideas and programs with each other. This exchange furthers their ability to conduct programs that have worked for others and to do so with a minimum of funding support. NFPA encourages this exchange through its membership and through its Learn Not to Burn Regional Representatives. Such activity has resulted in the expansion of successful programs from one community to another.

It is ironic that while firesafety education has proven to be a key element in effective fire prevention programs it still suffers from lack of recognition in budget decisions. When budget cutbacks take place in a fire department,

educational programs are often the first to fall victim to the cuts. Fire safety education should be reinforced in every community and must be a high priority as an investment in the future.

Local identity; targeted messages; positive, behavioral approaches; and use of the media all contribute to successful reception and retention of fire safety knowledge by the general public. Cooperation, leadership and exchange contribute to a more effective development and distribution of fire safety education programs.

ATTACHMENTS

- Attachment I Letter from Captain Tom T. Nyhan, San Francisco Fire Department regarding Learn Not to Burn Conference
- Attachment II Lives saved as a result of knowledge and skills gained through the Learn Not to Burn Curriculum
- Attachment III Lives saved as a result of knowledge and skills gained from Learn Not to Burn Television spots
- Attachment IV A typical media kit of the type supplied by NFPA
- Attachment V Learn Not to Burn Curriculum Information kit

(NOTE: In the interest of economy, the attachments listed above were retained in the files of the Committee where they may be researched upon request.)

The CHAIRMAN. Thank you, Mr. Gerard.
Mr. Flinn.

**STATEMENT OF DONALD D. FLINN, GENERAL MANAGER,
INTERNATIONAL FIRE CHIEFS ASSOCIATION**

Mr. FLINN. Mr. Chairman, my name is Donald D. Flinn, general manager of the International Association of Fire Chiefs and the deputy fire chief of the Silver Spring, Md. fire department.

I appear before your committee this morning to discuss the important issues of fire safety. For the sake of brevity, I will be moving away from my prepared remarks and going into some ad hoc comments as well.

Organized in 1873, the International Association of Fire Chiefs is a worldwide professional association representing the Nation's career and volunteer fire chiefs who are responsible for directing fire prevention and control activities, emergency medical services, and emergency response to disasters by local governments. The history of tragic fires and disasters has convinced our members that a collective and cooperative effort by local, State, and Federal governments as well as the private sector is necessary to mitigate the fire problem.

Residential fires continue to be the main source of fire deaths in the United States. In terms of life safety, the fire problem is overwhelmingly a residential problem. Residential fires claim approximately 79 percent of the deaths from fire and 68 percent of the injuries.

In nonresidential fires, arson is the major cause of fire deaths and injuries.

You have heard the numbers. You will hear them again today, and I will not reinforce them. I will only comment that numbers mean nothing to you or to me until it becomes a personal loss. When that personal loss touches your life, then the numbers that you have just heard from the previous speakers and myself and the numbers you have heard from the Chair will become important to you.

With these various causes of fire and deaths in mind, the IAFC has a long record of supporting various legislative efforts to reduce these unacceptable losses. Various Federal fire safety legislation, as well as numerous anti-arson bills, have been supported. The IAFC will continue to support and encourage this important fire safety legislation.

Let me also comment, Mr. Chairman, that fire safety and fire safety legislation at the Federal level are appropriate for consideration by the body, and certainly in reacting to a public matter.

In terms of fire safety programs and technologies, the use of smoke detectors in all residential and commercial buildings has long been an effort of the IAFC to support and encourage, and in fact encourage the mandatory use of those devices. Smoke detectors are an important source of early fire detection which give building occupants valuable seconds to flee from the threat of fire. There are hundreds of documented cases by fire departments where smoke detectors have saved lives, or where the installation of smoke detectors would have saved lives.

The IAFC also supports the use of automatic fire suppression systems for both residential and commercial buildings. Automatic fire suppression systems have a 96-percent success rate of suppressing the fire or at least containing it until the fire department arrives. The installation of automatic fire suppression systems will reduce the number of fire deaths and limit property loss due to fire. Other important benefits such as reduced fire insurance rates are the direct result of automatic fire suppression systems.

An equally important element of fire safety, as Chief Gerard has mentioned, is public education. Citizens must be made aware of fire safety in order to reduce deaths and property losses from fire. The IAFC has supported and developed many fire safety educational programs at all levels. Some examples are programs for elementary school fire safety education, nursing home fire safety, and many more. These programs are being conducted by our member chiefs on a continuing basis.

It has been stated that another fire safety concern is the fire toxicity problem. While one would expect that flame contact would be the major source of injury and death from fire, numerous studies have revealed that the majority of fire-related deaths and injuries were a consequence of exposure to the combustion products of natural and synthetic materials. Combustion products are a part of a complex, changing mixture of gases, aerosols, particulates, and material fragments which have been termed "smoke." Carbon monoxide is the most important of all those toxicants present in smoke, since it is the most lethal.

In actual fires it is frequently difficult to determine which toxicant or group of toxicants causes incapacitation or death. Often it is more important to determine the limits of survival rather than the mechanism of death from exposure to toxicants and toxic gases. The toxicity problem currently is being studied at the Center for Fire Research, National Bureau of Standards, along with many other organizations having a vested interest in toxicity issues.

In order to solve the toxicity problem, all sectors must participate if we are to arrive at a solution to the unacceptable death and injury rate. Everyone has a vested interest in achieving a solution to the fire safety and toxicity problem.

As a result of our concern for the toxicity problem, the International Association of Fire Chiefs at their 109th annual conference held in Philadelphia, Pa., last September passed the following resolution, and I will go right to the heart of the topic, if I may, sir:

Whereas, the increasing use of synthetics to replace traditional building materials and furnishings is exposing firefighters to high levels of such toxic gases as hydrogen cyanide, hydrogen chloride, nitrogen dioxide, carbon monoxide, and other toxic gases, and endangering citizens and firefighters; and

Whereas, toxic fume inhalation has caused death and injury to increasing numbers of firefighters; and

Whereas, toxic gases are produced in lethal levels in smoldering flaming and non-flaming heated plastics, often unnoticed by firefighters; and

Whereas, the public and fire service have not adequately been kept informed of these products;

Therefore be it resolved that the IAFC strongly recommend that the issue of combustion toxicology be examined when considering national, State, and local building and fire codes, and that scientific studies be undertaken to further clarify the role that such burning synthetics as PVC and ABS play in firefighter short- and long-term mortality and morbidity rates.

Let me just say to you, sir, that the International Association of Fire Chiefs will be conducting on October 3 through 5 in San Francisco a series of scientific tests demonstrating a new technology brought about by joint research of the Federal and private sectors in a quick-response sprinkler head. We are going to be using scenarios that have actually been found to be the origin and cause of fire spread from several fire situations involving residential properties, hotels, and such. I would invite the Chair and the committee members or staff to attend and witness these tests which will be conducted, as I said, in October.

I thank you for this opportunity to present the views of the IAFC on fire safety. I would be happy to respond to any specific questions the members of the committee may have on this issue.

[The prepared statement and responses of Mr. Flinn to questions submitted by Senator Hatch follow:]

STATEMENT
OF
DONALD D. FLINN
GENERAL MANAGER
INTERNATIONAL ASSOCIATION OF FIRE CHIEFS

Mr. Chairman:

My name is Donald D. Flinn, General Manager of the International Association of Fire Chiefs and Deputy Fire Chief of the Silver Spring, Maryland Fire Department. I appear before your Committee this morning to discuss the important issue of fire safety.

Organized in 1873, the IAFC is a professional association representing the nation's career and volunteer fire chiefs who are responsible for directing the fire prevention and control activities, emergency medical services and emergency response to disasters of local governments. The history of tragic fires and disasters has convinced our members that a collective and cooperative effort by local, state and federal governments is necessary to mitigate the fire problem.

Residential fires continue to be the main source of fire deaths in the United States. In terms of life safety, the fire problem is overwhelmingly a residential problem. Residential fires claim 79% of the deaths from fire and 68% of the injuries.

In non-residential fires, arson is the major cause of fire deaths and injuries.

The leading cause of residential fires in the United States is heating related. Heating fires accounted for 23% of all residential fires and is causing an increasing proportion of fires nationwide. The second major cause of residential fires accounting for 15% of the fires is cooking. Incendiary and suspicious fires are causing 12% of all residential fires. Smoking is the fourth major cause of residential

fires accounting for 9% of the fires.

The non-residential building fire category accounts for only 9% of all fires, but is attributed with 40% of the property losses in the United States. Arson continues to be the major cause of property loss in non-residential fires. Other major causes of fires in this category vary by property type.

With these various causes of fire and deaths in mind, the IAFC has a long record of supporting various legislative efforts to reduce these unacceptable losses. Various Senate and House fire safety legislation as well as numerous Anti-Arson bills have been supported. The IAFC will continue to support this important fire safety legislation.

The IAFC also supports the use of smoke detectors in all residential and commercial buildings. Smoke detectors are an important source of early fire detection which gives building occupants valuable seconds to flee from the threat of fire. There are hundreds of documented cases by fire departments where smoke detectors have saved lives or where the installation of smoke detectors would have saved lives.

The IAFC also supports the use of automatic fire suppression systems for both residential and commercial buildings. Automatic fire suppression systems have a 96% success rate of suppressing the fire or, at least, containing it until the fire department arrives. The installation of automatic fire suppression systems will reduce the number of fire deaths and limit property loss due to fire. Other important benefits such as reduced fire insurance rates are the direct

result of automatic fire suppression systems.

An equally important element of fire safety is public education. Citizens must be made aware of fire safety in order to reduce deaths and property losses from fire. The IAFC has supported fire safety education on all levels. Such programs as elementary school fire safety education programs and nursing home fire safety education programs are conducted by our member chiefs on a continuing basis.

Another fire safety concern is the fire toxicity problem. While one would expect that flame contact would be the major source of injury and death from fire, numerous studies have revealed that the majority of fire-related injuries and deaths were a consequence of exposure to the combustion products from natural and synthetic materials.

Combustion products are part of a complex changing mixture of gases, aerosols, particulates and material fragments which has been termed smoke. Carbon monoxide is the most important of all toxicants present in smoke. Since in actual fires, it is difficult to determine which toxicant or group of toxicants causes incapacitation or death, often it is more important to determine the limits for survival than the mechanism of death from exposure to noxious and toxic gasses.

The toxicity problem currently is being studied at the Center for Fire Research, National Bureau of Standards along with many other organizations which have a vested interest in the toxicity issue. Current studies by the Center for Fire Research include computer, laboratory and large-scale modeling studies. In order to solve the

toxicity problem, all sectors must participate if we are to arrive at a solution to the unacceptable death and injury rate. Everyone has a vested interest in achieving a solution to the fire safety and toxicity problem.

As a result of our concern for the toxicity problem, the International Association of Fire Chiefs at their 109th Conference, September 19-22, 1983, passed the following resolution:

RESOLUTION No. 4

WHEREAS: The increasing use of synthetics to replace traditional building materials and furnishings is exposing fire fighters to high levels of such toxic gases as hydrogen cyanide, hydrogen chloride, nitrogen dioxide, carbon monoxide and other toxic gases, and endangering citizens and fire fighters; and,

WHEREAS: Toxic fumes inhalation has caused death and injury to increasing numbers of fire fighters; and,

WHEREAS: Toxic gases are produced in lethal levels in smoldering, flaming and non-flaming heated plastics, often unnoticed by fire fighters; and,

WHEREAS: The public and fire service have not adequately been informed.

THEREFORE BE IT RESOLVED that the IAFC strongly recommend that the issue of combustion toxicology be examined when considering national, state and local building and fire codes and that scientific studies be undertaken to further clarify the role that such burning synthetics as PVC and ABS, play in fire fighter short and long term mortality and morbidity rates.

Thank-you for this opportunity to present the views of the IAFC on fire safety. I will be happy to respond to any specific questions the members of the Committee may have on this issue.

INTERNATIONAL ASSOCIATION OF FIRE CHIEFS • INCORPORATED

1329 18th STREET, N.W. • WASHINGTON, D.C. 20036

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833-3420**RECEIVED OCT - 7 1983**

October 3, 1983

Senator Orrin G. Hatch, Chairman
Committee on Labor and Human Resources
United States Senate
Washington, D.C. 20510

Dear Senator Hatch:

The attached is in response to your inquiry concerning additional questions on fire safety and toxicity. The International Association of Fire Chiefs (IAFC) believes that effective fire safety education and preventive practices, early detection and automatic suppression systems can greatly reduce the nation's losses from unwanted fires.

I have enclosed a brochure that describes a current project sponsored by the IAFC that will demonstrate the effectiveness of automatic sprinkler systems.

Thank you for your interest in fire safety. If I can be of further assistance, please do not hesitate to contact me.

Sincerely,

Donald D. Flinn
General Manager

Enclosure

DDF:kdn

Question One - What are the three things that could be done that would most reduce deaths by fire?

If most fire chiefs were given a choice of three things that could be done to reduce most deaths by fire, they would probably choose the following:

- 1) Sprinklers: Installing automatic fire suppression sprinkler systems in residential, transient residential (e.g., hotels), high occupancy and high hazard properties would definitely reduce deaths from fire. Sprinklers provide early and automatic fire suppression. Often they will extinguish a fire, or, at least, they will contain the fire until the fire department arrives. Sprinklers are cost-effective, they reduce the cost of public fire protection, and they reduce the tragic costs of fire.
- 2) Smoke Detectors: These devices provide early warning and detection of fire, which allows those few, precious extra minutes to escape and to call for help. They are effective in saving lives and property from fire.
- 3) Fire Safety Education: True and lasting fire safety can only result from an informed citizenry, attuned to the causes and results of fire.

Question Two - How do fire chiefs relate to local building codes? Do you ever attempt to influence them to include greater fire safety precautions?

Most model building codes have a companion fire code, which is not only a maintenance code, covering existing buildings, but also interfaces with the building code to provide for fire safety in new construction. Model codes are developed by private, consensus-making organizations, and fire officials do participate in their meetings. In addition, there is the National Fire Protection Association Life Safety Code which affects both new and existing buildings.

Most localities adopt or reference these codes, However, their enforcement is another concern. It has been found that there is a relationship between greater attention to fire safety in building plans and review and greater involvement by the fire service in the review process. Often enforcement of the building code is divided between the building and fire departments, with the fire department administering, or at least reviewing, the fire safety portion of the building code.

Question Three - Can you explain in more detail the International Association of Fire Chiefs' fire safety programs in schools and nursing homes?

The International Association of Fire Chiefs (IAFC) endorses greater fire safety in schools and nursing homes. These occupancies are very vulnerable and need greater protection. It supports many of the special code and inspection programs occurring on the local, state and federal levels.

Question Four - How do the fire chiefs evaluate the effectiveness of sprinklers and smoke detectors in hazardous fire situations for function, cost and safety?

The IAFC is constantly endeavoring to evaluate the costs and benefits of automatic sprinkler and smoke detector systems. The IAFC Foundation recently completed a study looking into the effectiveness of smoke detectors. This study was sponsored by the Federal Emergency Management Agency (FEMA). In addition, the IAFC is currently evaluating a new type of sprinkler head and piping for residential and commercial use. This is a public/private venture with principle sponsors being the Marriott Hotel, FEMA, and the nation's fire protection industry.

Question Five - How do you suggest we go about informing the public of the dangers of fires in order to reduce the number of deaths and injury from fires?

As mentioned previously, the key to reducing deaths and injury from fire is by having an informed public. The IAFC fully supported an earlier FEMA public education project involving the SESAME STREET television program for children. Teaching children about fire safety continues to be an important objective of the fire service, and has continually been credited with reducing deaths and injury from fire. Also, the use of television is an essential medium in communicating the importance of fire safety to the public. Approaching different audiences has also proved effective, e.g., fire safety information in hotel rooms, training for design professionals and building contractors, and providing information for retailers to use especially during the peak seasons.

The CHAIRMAN. Thank you, Mr. Flinn. Let me turn to Mr. Villella first.

Mr. Villella, do you feel combustion toxicity criteria should be included in major building codes throughout the country, and if you don't, why not?

Mr. VILLELLA. Mr. Chairman, I am going to turn to Mr. Wall, Administrator of the U.S. Fire Administration, to answer that question.

The CHAIRMAN. Mr. Wall.

Mr. WALL. Was the question to include the performance of materials as far as their toxic off-products are concerned, sir?

The CHAIRMAN. Do you think that combustion toxicity criteria should be included in major building codes?

Mr. WALL. If there were acceptable criteria, I think that would be a step forward. I am not convinced at this moment that we have such a tool. It would be extremely difficult to establish fair and equitable criteria with which to measure materials. Performance codes, as they presently stand, have a material do something rather than to specify it by brand, make, or product.

The CHAIRMAN. I see. Has FEMA done any studies, or has it addressed the issue of relative toxicity among combustible products?

Mr. WALL. No, sir, but such work is being carried on this year by the Fire Research Center within NBS. They assure us that in the near future they will be able to accurately measure what the toxic off-gases from a fire contain.

The CHAIRMAN. How do you suggest we go about informing the public about the dangers that really the public faces with regard to fires, in order to reduce the number of injuries and deaths as a result of fires?

Mr. VILLELLA. Mr. Chairman, we have on a number of fronts we have expanded upon the public fire safety education arena inaugurated by the National Fire Protection Association many years ago in their "Learn Not To Burn" activities. Just this past year, in January, we tripled our exposure to people in the public fire safety education area and hope to double again or triple again that same figure in January of this coming year. We have expanded the training of individuals who can conduct public fire safety education programs at the State and local level.

I would urge, Mr. Chairman, that you bear in mind when approaching this subject that we at the Federal level should do all that we can to provide assistance, with the help of industry, to the State and local levels which really have the task of providing education to the public and raising their consciousness about the subjects that affect their daily lives.

The CHAIRMAN. Thank you, Mr. Villella.

Mr. Gerard, why does NFPA believe that the present toxicity test methodologies cannot or should not be used by themselves for fire hazard assessment?

Mr. GERARD. First of all, we believe that combustion toxicity by itself is not an adequate measure of the fire performance of a product, just as saying that wood will burn, therefore we shouldn't use it, is inadequate. I think there are a variety of issues that need to be addressed. Ease of ignition; rate of flame spread; rate of heat re-

lease; rate of smoke generation. All of these issues, in addition to toxicity, should be measured.

One of the concerns that the toxicity committee addressed in their quite extensive study on what action should be taken was the fact that depending on the type of tests you use, a material in one test can be shown to generate no toxic gases, and using another test it can generate enormous quantities of toxic gases.

Under one test, for example, Teflon can be shown to be so hazardous that it probably should be banned from the face of the Earth. In another test it is not toxic. In fact I suspect that most everyone in this room uses a Teflon-coated skillet on a fire on their stove in the morning to cook eggs. If it were so incredibly toxic, perhaps we wouldn't do that.

I think there are other issues that need to be addressed, and I believe that is what the toxicity committee was addressing when they said that that alone should not be used.

The CHAIRMAN. Thank you.

Mr. Flinn, let me just ask you one question: How do fire chiefs relate to local building codes? Do you try to influence them? Do you try to use your organization's strength to influence them and help them to become less fire hazardous?

Mr. FLINN. Yes, sir. In many cases the codes themselves are developed in conjunction with efforts by the codemaking authorities, which would include fire chiefs and their area fire marshals on the developmental bodies. In addition to that, the fire chief is instrumental in the implementation or the adoption of an appropriate code for his community or, in the cases of many, within the State itself.

Of greater importance than the building code specifically, we feel, is the use and adoption of a life safety code, since the building code is concerned basically with the building proper and life safety is concerned with the occupants of that building. Therefore, we feel that the two need to be working hand in hand as opposed to only a single building code adoption.

The CHAIRMAN. Thank you. I have to go to another hearing, so I will turn to Senator Randolph at this time, and Senator Quayle will chair the rest of these hearings.

Mr. FLINN. Thank you, sir.

The CHAIRMAN. We certainly have appreciated having you here and listening to your excellent testimony.

Senator Randolph.

Senator RANDOLPH. Thank you very much.

Mr. Villella, we are told and have reason to believe that residential fires account for about 80 percent of all of what are called civilian deaths that are caused by these fires. It is said that cigarettes are a major cause of ignition in, according to my figures, 29 percent of all the home fires or residential fires. We are sure that you and others are addressing this issue.

I ask the question: Is there some type of cigarette that is being produced or capable of being produced that will not have a continuous burning, so that it could not be igniting something else? Would that help in a situation of this kind?

Mr. VILLELLA. Senator Randolph, there are, I think three factors to bear in mind: One, of the 29 to 31 percent of fires in residences

caused by smoking, the greatest subject of this percentage is fires caused by individuals who are smoking and who have been drinking alcohol. How deeply that impacts the fire problem is yet to be finally determined. But it is definitely a distinct, contributing factor; which is to say that smoking alone without some complicating influence does not necessarily and significantly contribute to creating fires.

The second point is that the substances that burn, be they synthetic or natural substances, are impacted by various ignition materials. Equally, the fire that is ignited can be ignited from the first second of a burn or the 20th second of a burn. I think the response to your question is, plainly, yes. There are fire-safe cigarettes which are projected to produce a shorter burning period of time which, obviously, has some impact on reducing ignition of fires.

Senator RANDOLPH. Thank you. In West Virginia, for example, of the figure that I gave of the total fire losses in 1981, beginning in July and ending at the close of June 1982, that loss was \$105,721,000 and there were 9,291 fires involved. The death toll might be considered high or low. There were only 62 deaths from the fires, and of course the residential fires that were covered, reported, were 3,235 and of that total of about \$105 million, \$63 million was in residential. Is that nationwide?

Mr. VILLELLA. That is an approximate figure for the Nation, Senator Randolph.

Senator RANDOLPH. I note that in West Virginia, of these fires that we have for fiscal year 1981-82, there were 294 fires that we attribute to arson. That is \$30,225,000 roughly, that figure as against the figure of \$105 million, so arson certainly is a very real problem. You have expressed it, but that goes beyond the training of firefighters. That goes to a second subject, and how do we attack that subject? Do you have any thoughts, as experts in this field?

Mr. VILLELLA. Senator, may I respond?

Senator RANDOLPH. Yes.

Mr. VILLELLA. We feel training directly impacts the arson problem. The very fact that many fire chiefs and firefighters, volunteers, and career, who receive the training that enables them to understand how to detect an arson fire, report back to us explaining what they use to think was an accidental fire, is now considered an arson proves training is valuable. Obviously, as in any other kind of discipline, our first requirement has to be to identify the nature of the problem before we can attack it.

What we have also done in the management of that arson problem is to identify that the majority of individuals who start arson fires are juveniles. This discovery was the causal factor for the juvenile fire-setter program. This program provides additional capabilities to individuals in local communities for dealing with the large portion of arsonists who happen to be juvenile fire setters.

Finally, my third response to your question. This year we have, I think, made a technological breakthrough in the establishment of microcomputer systems which will aid local communities in identifying and targeting the nature of their arson problem. There are presently seven pilot cities, and we hope to receive continuing favorable response from these pilot programs.

Senator RANDOLPH. Well, that is very encouraging. I did not realize what had been done or was being done, and I commend the efforts that you and others are making in this very necessary phase of firefighting which is, as you have indicated, educational in nature beyond the firefighters but within the communities themselves. Is that correct?

Mr. VILLELLA. Absolutely. We think, Senator, that fire is a community-based problem. Every fire chief in the United States knows the nature of his problem. We don't have to tell him or her that. We, on the Federal level, need to provide assistance to the State local people.

I wouldn't want my comments to give you the impression that we have solved the problem. I think it is absolutely appalling for us not to have made better progress in the self-contained breathing apparatus, which would aid not only the firefighters in this country but also the miners. We should have approached this technological endeavor much quicker than what we have. However, this calls for a concerted effort between the Federal Government and industry. We need to work harder toward the solutions.

Senator RANDOLPH. Are there formal training programs within not just West Virginia but throughout the country in our public school systems, on this problem of fire and the danger, as children grow through the elementary and secondary school systems?

Mr. VILLELLA. Yes, sir. In fact, one of the programs developed by the National Fire Protection Association is the "Stop, Drop, and Roll." This program instructs children in the classrooms usually during Fire Prevention Week, on techniques for reducing their exposure to smoke by stopping, dropping, and rolling out the danger area.

FEMA through the U.S. Fire Administration is participating with Children's Television Workshop in a significant project that reaches into the homes of the children throughout the Nation. The children's television workshop produces Sesame Street, a very popular program. The program delivers a fire safety message targeted at the child in the home. USFA helps to support this effort through a grant to CTW.

Senator RANDOLPH. Thank you.

Senator Quayle, I would like the record to indicate that Harold Schaitberger, the legislative director of the International Firefighters Union, was also scheduled to testify. It was necessary that he cancel being here today, and presumably testimony would be permitted from that organization a little later or in connection with the panel today, whatever you would feel would be appropriate. Is that right?

I know that organization through the years, and I have been privileged to share the responsibility of meeting with them many times. I recall especially one convention which was held in Des Moines, Iowa, and during the convention of the International Firefighters in that city—I will say it was not because of my remarks—there was a large fire that broke out nearby, and they had not so much a convention as they did an opportunity to serve, at least in the capacity of being helpful from the standpoint of their knowledge.

I repeat, these are very important hearings. They are not just routine hearings. These problems that face the body politic, the men and women and children of our country, are very, very important. The dollar loss is astounding, isn't it, if you check it out and see what really happens in one State or one county or one city.

I want for the chairman and for all of us only personally to say that it is good for this committee, Senator Quayle, to come to grips with a matter of this kind as you are giving us the opportunity to do. I think too often we just move in timid steps, and that is not enough. We have to make, as I call it, an all-out frontal effort, an attack on this problem throughout America. Again, I compliment you, not as a pleasantry but I feel this way. I hope that you will keep us at the task in the coming days and weeks.

Thank you.

Senator QUAYLE [acting chairman]. Well, thank you very much, Senator Randolph. We certainly appreciate your contribution and insight that I know you will be making in this issue, as you have done in other issues, on the committee. We will certainly be willing to accommodate, to work with you, and communicate any of the ideas or new facts or new actions that we ought to be taking with you and your staff. We appreciate the relationship we have had.

I wonder if each member of the panel might just comment briefly, if they can, on why we—meaning the United States of America—on a comparative basis have the worst safety record on fire in the developed world. Is there something that you can put your finger on? What is the problem. I think that is a revealing statistic. I didn't know that until I became interested in the issue how poor our record is.

I imagine if you would ask the average person on the street, Senator Randolph, if they thought the United States on a comparative basis had the worst record in fire safety in the developed world, I would imagine about 90 percent would say no, not the United States, leader in productivity, leader in gross national product, technological advancement, other things, military strength, economic vitality, and yet this statistic. Why? Who wants to go first? That is an easy, soft question.

Mr. GERARD. Well, Senator, the NFPA has been tracking statistics for years and years and years and years, and in fact we do it for everybody these days. Under a contract with the Federal Government, we continue to collect and analyze statistics. There really is not a statistical answer to your question.

However, I think we can look at several factors that do bear on it. A full exposition of that subject would take hours and hours and hours but in brief, No. 1 is, we have a lot more property to burn than many other countries. No. 2, the American people, all of us, have really approached the materials in our lives and our society as disposable.

For 30 years I have had the experience of talking to people after a fire. When I first became a firefighter, even a trash fire was something really exciting and I wanted to talk to people about it. As you go through your whole career you talk to people and you try to tell them about some recent fire, and the first question that people ask is, "Was anyone killed?"

Well, if someone dies in a fire it is something they want to know about. If no one was killed they say, "Oh, was anyone injured?" "Well, no, no one was injured." The third question is, "Was it insured?" "Yes, it was insured." "Oh, that's interesting. What else did you do yesterday?"

Really, fire is not a big issue with people, because you cannot dwell on the consequences of fire—put yourself in the position of receiving a phone call during this hearing to find that your home burned while you were gone this morning, and think about losing all your property, perhaps your wife and children everything in your whole life. Everything that you have at home that you cherish is gone. How long do you think you could dwell on that before you decide, "This is too morbid. I can't think about this any more."

Senator QUAYLE. However, it is true, isn't it, the statistic that we have a five times greater mortality rate than our European brethren?

Mr. GERARD. Yes, sir, the American home is different than the European home. The American home is open. The European home is a whole bunch of little compartments. The typical European home is built of stone and brick. The American home is full of wood and other materials that burn.

Senator QUAYLE. More combustible?

Mr. GERARD. More combustible, yes, sir, plus we are a high energy use society. You have dealt, I am sure, ad infinitum, with the energy problem in this country. Where are we going to get the energy that we use? We use energy every place—electricity, kerosene heaters, wood stoves, fuel oil in our furnaces. We use energy, energy, energy, energy—gasoline to power our lawnmowers, gasoline to power our automobiles. We are surrounded by energy use.

The more energy we use, the more heat we produce. The more heat we produce, the more opportunities there are for the misuse of that energy, whether it is electrical, smoking, gasoline, whatever it is. The misuse of that energy that we surround ourselves with creates a big part of the problem.

Senator QUAYLE. Briefly, what can we do about that?

Mr. GERARD. I believe that public education, the improvement of products—you know, the products that we surround ourselves with are highly combustible. It has been said—and I am sure the people from the manmade fibers or the plastics industry can identify for you how much plastic, combustible plastic we are adding to our environment every day—I have been told that it is somewhere in the neighborhood of 15 pounds per years that is added to the American home in the form of polyurethane foam, styrene fronts on TV's and cabinets, plastic dishes, plastic clothes, plastic shoes, plastic carpets. Those materials are not sinister in and of themselves but they do burn, and they burn at a faster rate than the old-fashioned materials.

While the fire departments and the Fire Administration and the people involved in fire protection have been working very hard and very successfully to deal with the fire problem, the problem has been changing. The fact that there are fewer fires, less dollar loss, fewer lives lost today than there were 5 years ago I think is an enormous tribute to the fire service, to the people in the Fire Administration and the other organizations in the fire protection field

for putting together a program that in the face of everything else going up—population increase, inflation, number of homes, number of automobiles, amount of energy use, all of that in an upward trend—the fire statistics are coming down. They are not at a successful level but they are running counter to the trends of all of the other factors in our society.

I think that is a real tribute to the fire service, but we need to continue. We need your leadership. We need the leadership of public officials everywhere to hold everyone's feet to the fire, to tell the average citizen they have to care about fire protection because it is a serious issue. Wouldn't it be nice if you could walk into budget hearings with \$24 billion in your pocket? Wouldn't that be terrific? That is what we waste with fire every year.

Senator QUAYLE. Yes, that would help the deficit a little bit.

Let me ask a further question. You brought up the plastics issue and some of the problems that we are having with the way that we are building homes, but you are also saying that the total number of fires is coming down. There has been a lot of discussion of the so-called toxicity issue, toxic fumes, the toxic smoke from materials in building fires. How serious of a problem is this?

Mr. GERARD. I believe it is, and I believe the NFPA would agree and our Toxicity Committee would agree, it is a very serious issue and has been for years and years and years. What we need to do is to continue the research to identify specifically what are the toxicity issues that we are dealing with? We know that carbon monoxide is the most overwhelming problem, but that exists in wood and cotton and everything.

Senator QUAYLE. That has always been a problem, hasn't it?

Mr. GERARD. Yes, sir, that is correct. That has always been a problem. What we don't know is—I believe it was mentioned recently by the former fire chief of Seattle, Gordon Vickery, and former Fire Administrator—the invisible killers in fire, the ones we don't know about. Why do people die when the carbon monoxide level in their blood is not high enough to be lethal? We don't know the answer to that.

That is why the Fire Administration and FEMA are supporting the protocols for coroners to use a better autopsy on fire deaths. We need to identify why people are dying, if they are dying differently today, and there is some evidence to indicate they are. We don't know why. We need to find that out.

I heard a combustion toxicologist mentioning the other day that in the typical residence either you escape from a fire or you die quickly. Quickly enough that carbon monoxide is the major killer. In a large building, where you are liable to be subjected to the fire gases for a longer period of time, other gases come into play. I don't know whether that is true or not; I am not a combustion toxicologist. And not everyone would agree. It is a very dynamic issue in science.

Senator QUAYLE. I wonder if you would agree with the testimony, the statement that Mr. Villella made concerning the research, that we need to get the cooperation with the Federal Government and the private sector, various factions of the Federal Government. Would this be a way that you would think we ought to continue

research, to make this identification with the private sector as well as the public sector?

Mr. GERARD. Yes, sir. I believe that over the past several years the cooperative efforts between the Federal Government and State and local government have really been good, and we need to continue that. In Los Angeles with Federal funding we did tests on smoke detectors. We did some of the very earliest tests on the quick-response sprinkler head that is today altering the fire safety picture in the average home. I think these are things that need to continue, and the research effort needs to be a joint effort between the private sector and the public sector. It isn't just a Federal responsibility; it is something that the private sector has to be involved in also.

Senator QUAYLE. In other words—and, Mr. Villella, you can comment on this if you would like to—in other words, you would like to see perhaps an enhancement of the stature of publicity, of a group mechanism or whatever you want to label it, of working together with this problem on fire prevention, the toxicity problem, the identification of what we ought to be doing. Is this correct, and is this the recommendation that you would be wanting to leave with the committee?

Mr. VILLELLA. Mr. Chairman, I know now why your colleagues speak so highly of your performance. That is precisely what we think we need to do. It is not a single faceted issue. It involves all of the components of the fire safety problem. If we would be able to conduct some meetings, do some research, convene discussions where we can address all of the issues falling under the umbrella of fire safety, I think we could make substantial progress. I think that my colleagues at the State and local level and in industry would agree with that approach.

Senator QUAYLE. Are there any specific suggestions that you might want to give us on how we ought to proceed with creating this type of environment?

Mr. FLINN. Senator, if I may for just a minute, I realize you are on a roll to a certain extent but I feel there is something I have to interject here. It seems to me that a point that is being overlooked that I would like to focus on for just a moment is the fact that there are several parallel tracks that need to be taken when dealing with the fire problem, both in terms of the national fire problem and in terms of the particular issue you are focusing on right now.

First of all, we are looking at two safety issues. One is the occupant themselves in terms of the individual who is going to be most exposed to the products of combustion in a fire, whether that person is sleeping or awake. Second, it is the firefighter who must come into the building and intervene in that fire process, interrupt it to the point that the fire is under control, confined, and extinguished. I think those issues are two separate things that need to be addressed, and perhaps addressed separately in terms of research activities, testing procedures, and certainly in terms of some of the medical protocol that is being encouraged.

The second part of that in terms of this matrix we are looking at is the building itself, and we are talking about the application and use of building codes in this activity as well as the introduction and

use of certain kinds of fire safety devices and equipment, and the building products that are used to furnish that building, whether it is wall coverings, wallpaper, paint, whatever it is, as well as the furnishings that are brought into the building itself as we have in this hearing room.

I feel very strongly—and you have heard the testimony that seems to roll around these issues—and I don't believe there is any simplistic way to quantify the problem. In many cases you will find that the fire products—as has been stated and I am sure you will hear from the scientists that are better able to present this in factual sense—they will indicate that there may be a synergistic effect in the reaction of the building, the building products, to fire; that it may be such a reaction, one within the other, that there is a multiplier effect in both the products of combustion that lead to a fatal or toxic result and in ability of the fire department in some cases to quickly control, intervene in that process.

The point that appears to me to be necessary is multiple: First of all, the public needs to be made aware, as has been mentioned, of the dangers of fire. We are too ill-cautious. We are not properly equipped to deal with a fire, whether it is a simple fire—and by “simple” I mean not within a building but a gasoline lawnmotor catching fire while a person is refueling the device, or an outboard motor of something of that type that catches fire—we are not equipped to deal with that quickly and promptly to avoid injury.

Second, even though we know there are proven devices on the market that can reduce the life loss and injury—that is, smoke detectors—they are not universal. There is no universal application of smoke detectors in buildings.

The third thing, of course, is the inability of many fire departments to gather their resources adequately to restore a building or control a fire situation.

I guess the last is, how do we deal with all this: The IAFC has been organized for over 110 years, the NFPA for slightly less than 100 years. It is an age-old problem. The U.S. Fire Administration has been in operation for a short period of time. We are finally achieving some significant results, only because—and I feel this with a great deal of sincerity—only because we are finally getting the attention of the shakers and movers in this legislative body to recognize that fire is not a local issue. I, as a local fire chief or code enforcement official, have to deal with the same problem as my peer in Los Angeles or Petaluma or Peoria, and the problem is universal.

I have taken your line. Thank you.

Senator QUAYLE. Now, Mr. Flinn, I just wonder if I might add to that and to get your endorsement of the way we are trying to move, to see if in fact you think it would be beneficial for us to try to proceed with the continuation of research to try to get this joint effort between the public sector and the private sector.

You pointed out that we have had these institutions, very well respected, that have been around for a long time but we haven't been able to catch the public's eye, and that we are too ill-cautious or lax in our concern about fire. I wonder, if we come out of these hearings and move this issue forward in the arena of public scrutiny and public interest, this idea that has been brought up and dis-

cussed, whether we really ought to try to move in this context of getting the cooperation of those in the private sector that are interested and involved in this and those in the public sector?

Mr. FLINN. Yes, sir. I not only endorse but enthusiastically encourage that being done. Fire safety at the national level is generally a major response to an incident. Many of us in the fire service at the national level have been encouraging for years and years and years the recognition by the transportation bodies, the FAA and CAB and such, to recognize that fire safety is limited in aircraft today. Hopefully some of the very tragic situations that have come about in the recent weeks will cause some significant change to take place with regard to aircraft safety.

I can recall a very distinguished gentleman who was an advisor to the early space program who cautioned NASA, when they went into an oxygen-enriched atmosphere with the space capsules that resulted in the very tragic loss of three astronauts, who said, you know, "We told you so." This is something that, as Chief Gerard has mentioned in his 30 years experience, and my 28 years experience, we keep telling you the same things over and over again. The numbers rarely change, and I think it is only because of the efforts of the Fire Administration and the Members of Congress like yourself, sir, that we can begin to change the numbers, and numbers are people.

Senator QUAYLE. Thank you. Thank you very much. I appreciate the contribution this first panel has made. We will be communicating with you after these hearings and look forward to, hopefully, a mutually beneficial relationship. Thank you very much.

Mr. GERARD. Thank you, Senator.

Mr. FLINN. Thank you, sir.

Senator QUAYLE. Now, Dr. John Lyons and Mr. Wayne Ellis.

Dr. Lyons is the Acting Deputy Director of the National Bureau of Standards. We have our little box here. If you will be so nice as to indulge in the limits of time, we would appreciate it. Thank you.

STATEMENT OF JOHN W. LYONS, ACTING DIRECTOR, NATIONAL BUREAU OF STANDARDS, ACCOMPANIED BY JACK SNELL, DIRECTOR, CENTER FOR FIRE RESEARCH

Mr. LYONS. We do have a very long statement, which I understand will be included in the record.

Senator QUAYLE. We will put that in the record.

Mr. LYONS. I am pleased to note that I have with me today Dr. Jack Snell, to my left, your right, who is currently Director of the Center for Fire Research at NBS; I was the first director of that center.

I want to touch on seven points quickly this morning: First, the role of NBS in this matter; second, the tradeoffs one has to make in considering fire safety; third, the causes of fire deaths; fourth, the toxicity of various polymers; fifth, the fact that we consider there is no single magic solution to the problem; sixth, the current state of the art; and, seventh, a longer term outlook.

The NBS Center for Fire Research was created—established—by the Federal Fire Prevention and Control Act of 1974. Prior to that time, NBS had run a smaller program dating back to the great Bal-

timore fire of 1905, when it was discovered that various fire departments had nonstandard threads and could not hook up to the Baltimore hydrants. So we have been at work for a very long time in this area.

Our role under the act is to conduct research on all aspects of fire and its effects on its victims as well as to make these results available to the community at large. I hasten to note that we do not issue standards or new code provisions from the Bureau of Standards, despite our title.

The second point I want to make—and I want to emphasize this—is that when considering fire safety one always has to make tradeoffs. The tradeoffs are among safety, function, and cost. It is technically possible today to build and furnish a structure with noncombustible materials, but that solution is expensive and often neither pleasant nor functional. You can imagine having to live in fiberglass clothes and to sit on concrete furniture. Therefore, officials having jurisdiction have to make these tradeoffs.

Let me comment briefly on the causes of fire deaths in this country. The only study—the only solid study—ever made of this subject was done in the State of Maryland during the 1970's under the auspices of the Applied Physics Laboratory of Johns Hopkins University, and sponsored by the National Science Foundation and subsequently by the National Bureau of Standards. Between 400 and 500 fire fatalities were studied over a period of several years through very careful medical examination of the victims. The results are classified in two areas, first, those who died immediately or within 6 hours of the fire and, second, those who died sometime later.

Some 80 percent of the fire fatalities occurred within the first 6 hours. Of that 80 percent, four-fifths were related to carbon monoxide directly. The balance were due to falls, heart attacks, and the searing of lungs by the heat of the gases inhaled. Of the 20 percent that occurred subsequent to the first 6 hours, roughly one-half were attributed to burns and one-half to what we term "chemical pneumonia" or the long-term effects of inhaling fire gases.

Looking now to the polymers themselves and what gases they give off, nearly all such polymers used in our society give off carbon monoxide when burned in a fire. That is simply because there is incomplete combustion, so that the chemical reaction does not proceed to completion, which would produce carbon dioxide, a much less toxic product. Many modern polymers used commonly give off other toxic gases, some at relatively low levels, but almost always these are accompanied by substantial amounts of carbon monoxide.

In my testimony I have taken a table from a report of the National Bureau of Standards which shows results of toxicity testing at NBS. The bottom line in that table is this: That most common synthetic polymers exhibit the same order of magnitude of toxicity as common natural polymers, such as wood, cotton, or wool. I might point out parenthetically that all of those last three are very toxic.

In general, I would assert that there is no single magic solution. There is a great tendency in the fire prevention business to look for a single panacea, and we don't see one. For example, rigid con-

trol of materials, or sprinkler everything, or public education, or more fire apparatus—none of those by itself would solve this problem.

Let me give you an example. It was mentioned earlier that one common fire scenario for fatal effect is the smoldering fire at home. We studied that one in great detail. It takes place at home, typically at night, while people are asleep. The ignition source is a cigarette dropped on upholstered furniture; whether because people are too tired or too inebriated is another variable. It creates a smoldering fire, that is, there is relatively little heat and no flame. It produces toxic gases. The toxic gases gradually fill the house and fatalities occur, usually in a room remote from where the fire started, so that the fire service reports that when they were finally called, everyone was dead before the call was received.

Looking at this fire scenario, there are several ways to intervene. You can look at the cigarette, which has been discussed. You can consider changing the construction of the furniture. You can insist on the installation of smoke detectors. You can change the design of the house so as to compartmentalize it. You can educate the occupants. We are, in fact, in this country working on all of these.

The current state of the technical art is that in order to make decisions concerning materials or any other aspects of fire safety in structures, one now requires data from a large number of tests, some of which have been enumerated, and then one requires an expert to interpret the data. That expert in our society is the local code official.

Finally, I would say that our long-term objective at the National Bureau of Standards—and we think it will take another 5 years—is to develop a model into which test data, design information, and code requirements can be fed—typically into a computer—and from which we can retrieve a prediction of the impact of a change in material or design on the time to escape. As I said, Mr. Chairman, that is about 5 years off.

[The prepared statement and responses of Mr. Lyons to questions submitted by Senator Hatch follow:]

STATEMENT OF DR. JOHN W. LYONS
ACTING DEPUTY DIRECTOR, NATIONAL BUREAU OF STANDARDS
U.S. DEPARTMENT OF COMMERCE
BEFORE THE
SENATE COMMITTEE ON LABOR AND HUMAN RESOURCES
HEARING ON FIRE SAFETY ISSUES
JULY 19, 1983

1. Introduction

I am John Lyons, Acting Deputy Director of the National Bureau of Standards (NBS). I am accompanied this morning by Dr. Jack Snell, Director of the Bureau's Center for Fire Research (CFR). We are pleased to have this opportunity to testify before the Senate Committee on Labor and Human Resources on fire safety and, in particular, the activities of the Bureau's Center for Fire Research.

I shall say a few words about fire safety as we view it, I shall describe CFR and its programs, and then focus my remarks on our work relating to smoke toxicity and its contribution to the overall hazards of fire.

2. A Perspective on Fire Safety

Fire safety is a complex matter. Further, fire safety inevitably involves tradeoffs. Typically, it is not a matter of safety at any cost. If that were the case, all buildings would be made of concrete or steel, with furniture and furnishings made of spaceage foams and fabrics, and would be occupied by people clothed in fiberglass garments. But the populace does not want that. Thus, tradeoffs are required. These usually involve considerations of function, e.g., comfort and convenience, and cost as well as safety from fire or other risks.

Therefore, serious efforts to reduce this nation's fire losses--the U.S. fire death rate is over two times the international average--must include a balanced set of technologies and measures that are publicly understood to be cost-beneficial, usually by individuals and by local or State level decisionmakers.

The physical hazards of fire to human life arise from flames, heat, and the effects of smoke (fire gases and particles). Fire incident data reveal that only ten percent of fire victims are killed by flames or heat. Most of the rest are killed by the effects of inhalation of smoke. (I'll come back to this later.) Two-thirds of all fire fatalities involve people located far from the room of fire origin. Many typical residential fires are started by smoking materials dropped on furniture or bedding or exposure of combustibles to unattended solid-fueled stoves or heaters. Typically most fire fatalities involve people who are either very young or old or otherwise incapable of effecting their own escape.

Thus, there is a solid factual basis for present-day concern about the hazards of smoke from accidental fires.

What can be done to address this hazard? Obviously, if there is no fire there is no smoke hazard, so fire prevention measures are important. However, since many fires are nonetheless likely, a variety of measures exist to facilitate timely and safe occupant escape or rescue. These include early warning devices such as smoke detectors, fast-acting sprinkling systems which can effectively knock down a fire before it reaches hazardous levels, systems for smoke control, and fire safe building design practices. Just as important are measures to limit use of certain materials or products in certain applications so that hazardous conditions do not develop too rapidly. It is widely recognized that the flammability properties of building contents--i.e., furniture, furnishings, etc.--represent a more serious concern than materials of construction in this regard.

All of these measures and others have an important role to play. The difficulties faced by the local fire or code official are in evaluating the relative effectiveness of such measures in various likely situations and in performing the tradeoffs I described earlier between function, cost and safety.

Essential to all of this is a sufficient knowledge and understanding of the fundamental phenomena involved in fire to develop predictive tools for such decisionmakers. The central focus of the Center for Fire Research is to provide the technical basis for such tools.

3. The Center for Fire Research

The Center for Fire Research at NBS was established in 1974 by Section 18 of the Federal Fire Prevention and Control Act of 1974 (P.L. 93-498). Before this, NBS conducted a smaller fire safety engineering effort within its building research program. The Bureau's work in this area began in the aftermath of the Great Baltimore Fire of 1904.

The CFR has a staff of 111 people and an FY 1983 budget totaling about \$5.9M in direct appropriations. Another \$3.5M is expected in reimbursements from other Federal agencies. Of the direct appropriations, \$2M is being used for research grants. This \$2M represents the bulk of funding for fire research at universities in the United States.

The Federal Fire Prevention and Control Act directs the Center to perform and support "research on all aspects of fire with the aim of providing scientific and technical knowledge applicable to the prevention and control of fires." This includes, explicitly, basic and applied fire research on a broad range of topics pertinent to reducing the losses from fire.

Over the last nine years, we have made notable advances in our knowledge of important aspects of fire and have also provided practical and useful results. For example, we can now predict important phenomena such as "flashover" and smoke movement in buildings easily and with reasonable accuracy. Also, CFR has contributed to the widespread use of smoke detectors, test methods for mattresses and upholstered furnishings, and has developed and implemented practices useful to code officials in evaluating the equivalence of alternative fire protection approaches in meeting specified levels of fire safety.

Perhaps as important, our research has demonstrated the viability of using computer-based simulations of virtually all types of fire situations to develop, and evaluate, means to reduce fire losses and the costs of fire protection. We view this as an extremely exciting and significant development.

Our activities include small- and large-scale test programs to validate such models and development of test methods industry and others may use to provide the needed data on commonly used materials and products. Also, we are developing benefit-cost and risk analysis tools to aid in the evaluation and solution of fire protection products or practices by manufacturers, designers, engineers, and fire officials. A brochure describing the Center for Fire Research, the Center's research plan, and a copy of Section 18 of P.L. 93-498 are included as Appendices A through C.

4. The Background of Research on Combustion Product Toxicity at the Center for Fire Research

As I said at the outset, most of the people who die in fires succumb from smoke inhalation. However, only a few studies have attempted to pinpoint more closely the causes of death from fire. The most comprehensive of these is the study reported in 1978 by the Johns Hopkins University Applied Physics Laboratory with funding originally by the National Science Foundation and later through the CFR grants program.^{(1)*} Data were drawn from local fire reports, investigation reports, and detailed autopsies. The results are shown on the following page.

*Numbers in parentheses identify references listed on page 15

Data on Fire Fatalities in Maryland^(a)

<u>Time of Death</u>	<u>Fraction of Total Deaths</u>	<u>Cause of Death</u>
<6 hours	.80	
after fire	.16	falls, heart attacks, lung searing
	.48	CO poisoning
	.16	CO plus physical predisposi- tion ^(b)
>6 hours	.20	
after fire	.10	burns
	.10	lung disease from effects of gas inhalation
	1.00	

(a) 463 autopsies from 1972 to 1977 representing about 2/3 of all fire fatalities in the State in this period.

(b) Presence of circulatory disorders rendering victims more susceptible to CO poisoning; presence of high levels of alcohol in the blood.

Carbon monoxide is produced in all fires of interest. Hydrogen cyanide is produced in fires fueled by materials containing nitrogen; e.g., silk, wool, polyurethanes, and acrylic fibers. Hydrogen chloride, another combustion product toxic in moderate amounts, is produced when poly(vinyl chloride) ("vinyl" plastic) is burned. Results of laboratory tests show that most commonly used materials produce roughly similar toxic effects in test animals. The tabulation given here is from NBS test data. (See table on following page).

In the NBS work shown, the three natural materials -- red oak, wool, and Douglas fir -- are at mid range with the synthetic materials falling both above and below them (above is less, below is more toxic). Other test procedures or other test conditions in this procedure produce somewhat different relationships, but this list is illustrative. There is no definitive or absolute reference procedure against which to compare the findings. Note that the 95% confidence limits are sufficiently broad to permit considerable overlap and hence possible rank-order changes. One certainly cannot say that poly(vinyl chloride)(PVC) is substantially more toxic in this particular test series than Douglas fir, for example. It is our opinion that since the results are somewhat dependent on the design of the test method and since there are considerable uncertainties in the test results, one should focus only on relatively large differences -- say a factor of ten. If one takes this view then the tabulation points to only one material -- poly(tetrafluoroethylene) (PTFE) -- that is more than ten-fold more toxic than the three natural materials. (There are special factors in the PTFE case that make it different from the others and which require consideration of the chemical environment in the fire. See the footnote to the table.)

Selected NBS Test Results^(a)LC₅₀, non-flaming, 30 minute exposure plus 14 days

observation

<u>Material</u>	<u>Concentration in test atmosphere for 50% fatalities (LC₅₀)^(b)</u>
Polystyrene	>40, non affected
Rigid urethane foam	>40, non affected
Acrylonitrile-butadiene-styrene (ABS)	31 (21-45) ^(b)
Red Oak	30 (26-35)
Flexiblurethane foam	27 (15)-46)
Wool	23 (22-28)
Douglas fir	23 (20-26)
Poly(vinyl chloride) (PVC)	20 (15-27)
Poly(vinyl chloride) with retardant added (PVCZ)	11 (8-15)
Polyphenylsulfone	9-1/2 (9-10)
Modacrylic	3 (4-7)
Poly(tetraflouroethylene) (PTFE) ^{3(c)}	0.05 (.02-.12)

(a) See ref. 5, Table 17, on pp. 121-2

(b) Number in parenthesis are 95% confidence limits

(c) PTFE is very difficult to ignite. PTFE is also an unusual material in that it contains no hydrogen atoms. Its thermal decomposition is likely to be different in the presence of other fire gases compared to the situation in the test furnace. This effect is now being debated in the literature. The argument over PTFE is not relevant to the other materials in the table.

Solid data on fire deaths caused by toxicants other than carbon monoxide are hard to come by, in part because whenever there are high levels of other toxicants in the blood of fire victims there are also high levels of carbon monoxide. There are some reports of deaths where carbon monoxide levels were well below the usual lethal level in the blood but there is no data base equal to the Maryland study to demonstrate that these other gases present a continuing everyday hazard to life. Nonetheless, the possibility exists that new materials could be developed or introduced that have inhalation toxicities significantly greater than those produced by traditionally used materials such as woods. Thus, starting in about 1974, CFR and others undertook development of inhalation toxicity test methods that could be used to detect, or screen for, such unusually hazardous combustion products before the widespread introduction and use of the new materials.

Early work towards a toxicity test method was supported by the Product Research Committee (PRC), which was formed in 1974 as part of a consent decree entered into by the Federal Trade Commission and 25 respondents from the cellular plastics industry.⁽²⁾ I was privileged to serve as chairman of this committee. The mission of the PRC was to administer a research program through grants to investigate behavior of cellular plastics in fire, especially in areas of fundamental research, small- and large-scale testing, and toxicity of combustion products. Under the sponsorship of the PRC, a small-scale test procedure

consisting of a combustion system, chemical analysis system, and an animal exposure system was designed and tested. The results of that early work were published as a report of NBS.⁽³⁾ In January 1976, an interagency meeting was held by NBS to examine concerns and programs of various governmental agencies in the area of combustion toxicology. Agencies represented were the Consumer Product Safety Commission, the Department of Defense, the Department of Transportation, the Environmental Protection Agency, the Energy Research and Development Administration, the Federal Aviation Administration, the National Aeronautics and Space Administration, NBS, the National Center for Toxicological Research, the National Institute of Environmental Health Services, and the National Institute for Occupational Safety and Health.

In November 1977, an ad hoc working group was formed by NBS consisting of members from approximately twenty academic, industrial, and governmental organizations engaged in work relevant to smoke toxicity. This group provided a forum for exchanging technical information to assist NBS in the development of a small-scale laboratory test to assess the inhalation toxicity of smoke. Subsequently, seven members of the ad hoc working group participated in an interlaboratory evaluation of one version of the test method.⁽⁴⁾

These efforts led to publication in June 1982 of a report entitled "Further Development of a Test Method for the Assessment of the Acute Inhalation Toxicity of Combustion Products" (NBSIR 82-2532) by NBS.⁽⁵⁾ This report documented the status of development of a smoke toxicity test method intended primarily for use by product researchers and materials manufacturers for research and preliminary screening purposes in developing and evaluating materials. The test method is not intended to be used by itself in evaluating the fire safety of a material since a number of additional factors must be considered for a given situation. The report specifically notes these factors as follows:

"Additional factors that must be considered in evaluating the toxic hazard posed by a material in a given situation include, among others: the quantity of material present, its configuration, the proximity of other combustibles, the volume of the compartments to which the combustion products may spread, the ventilation conditions, the ignition sources, the presence of ignition sources, the presence of fire protection systems, and the building occupancy. Therefore, the results of this test method must be combined with other pieces of information if making decisions about the suitability of materials for specified uses."

In view of the expressed concerns of industry, of State and local governments and national fire and building organizations over the topic of smoke toxicity, NBS sponsored in September of last year a workshop on this test method, its appropriate uses and limitations, and planned research on hazard assessment. A summary of that workshop was published.⁽⁶⁾ About 70 persons from industry, fire code and building officials, researchers, and others attended this workshop. A second workshop--covering essentially the same material--was held in San Francisco in February 1983.

In the Continuing Resolution for appropriations for FY1983, the Congress appropriated an additional \$350K to the Center for Fire Research for research on the toxic effects of combustion products during unwanted fires. CFR is to establish quantitatively the relative contribution of smoke toxicity to the overall hazards of fire generally, and, in particular, to establish the extent to which particular materials or products may significantly increase the hazards of accidental fire.

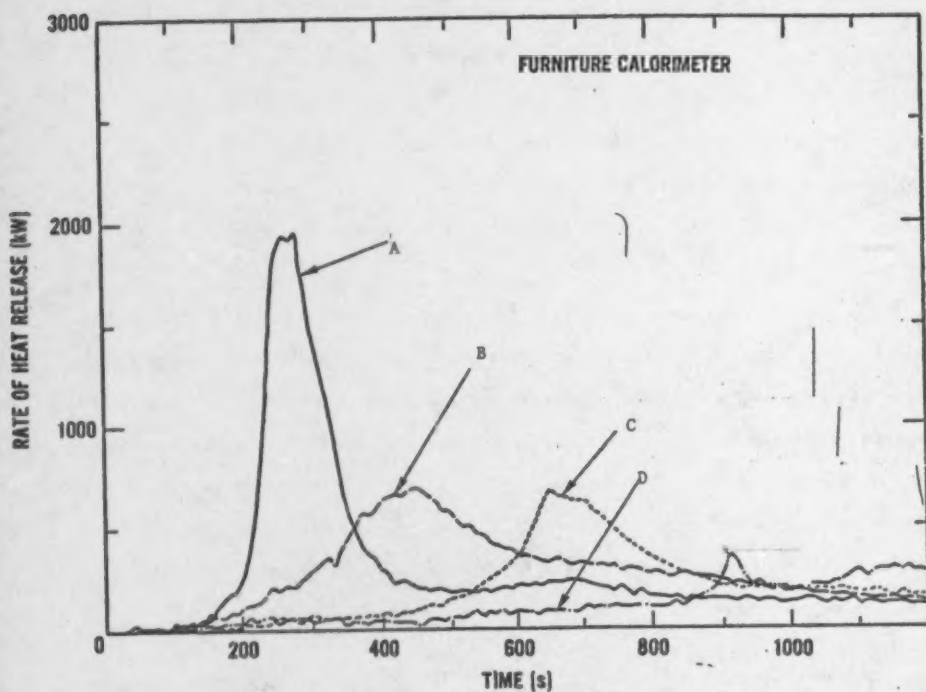
Since that time, the Center has worked out a strategy for developing such a methodology for toxic hazard assessment. It was discussed in preliminary form in the aforementioned workshops. The general strategy approach appeared as a "Forum" contribution in the Journal of Fire Sciences in January 1983.⁽⁷⁾

Subsequent to that time more detailed presentations on current and planned CFR toxicity work have been widely discussed and reviewed with representatives of materials makers, State and local governments, and the standards community. Our intent in all of these discussions has been to solicit critical review, guidance and comments to facilitate our progress in this important work. The response has been supportive of our planned approach.

Approval for the first grant under this program has just recently been received. This work will be conducted by Southwest Research Institute, San Antonio, Texas which has outstanding capabilities in smoke inhalation and toxicity studies. Additional grants are planned. We have approximately \$650K annual effort underway within the Center for Fire Research on the toxic hazard assessment program in addition to the \$350K of grants to be awarded for this work.

Our approach to assessment of toxic hazard is simple. Consider a building in two parts--a room of fire origin and everywhere else. Assume an occupant far from the room of fire origin. (This is the situation for two-thirds of those killed by fire annually.) The toxic hazard for this individual depends on (1) how much smoke comes out of the room of fire origin; (2) how long it takes to reach the occupant; and (3) the concentration of various gases in the smoke that reaches the occupant. We are developing models for each of these suitable for running on computers.

Critical components of these models are data on the detailed fire processes involved in the room of fire origin--ignition, heat release, flame spread, rate of smoke production, and smoke toxicity. We are developing test methods to determine how commonly used materials and products contribute to each. Results of one test series on upholstered furniture are shown in the figure on the next page. This study of the rate of release of heat from the items shows some of the complexity of the problem. The total amount of heat released (the area under each curve) is different for each item but not by a great deal. However, the rate of release is strikingly different. Item A produces a fast and therefore very hot fire. Generally this means a much greater tendency for the fire to spread and grow. The hazard is, for A, from the rate of burning, not the final amount of energy released. To pin down variables for models we need test methods and extensive data banks obtained by running the methods on a variety of materials. This work is well along at NBS and elsewhere.



Rate of release of heat for four upholstered chairs, similar in construction but varying in padding and fabric covering.

Three types of fires are pertinent for the room of fire origin--a smoldering object; a rapidly growing, flaming fire; and a steady, fully developed fire. Ultimately, we shall look at each in detail; we are beginning with the fully developed fire. Initially, we treat the room of fire origin as a gas or smoke generator. We shall begin with a series of experiments to determine the extent to which we can characterize the fire gases produced as a mixture of specified pure gases, each of known toxic effect. This will involve principally CO, HCN, and HCL; real materials; and full-scale tests. The NBS toxicity test is being modified with a new fire exposure system that will permit exposing materials to a variety of temperatures, radiant energy fluxes, and oxygen-deficient atmospheres.

Also, the Center for Fire Research has cooperative programs dealing with smoke toxicity with Canada in the laboratories of the National Research Council in Ottawa and with Japanese researchers at the Japanese Building and Fire Research Institutes.

Our overall objective is to develop, validate, and make available a technically sound toxic hazard assessment methodology within three to five years.

Recognizing the immediate needs of fire and code officials for guidance in this area, we will provide estimates of the hazards from smoke in about one year based on laboratory, analytical, and full-scale tests.

This has been a brief review of the NBS work on the fire problem with emphasis on the toxicity of combustion products. Dr. Snell and I will be pleased to try to answer any question the Committee may have. Thank you.

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1. Berl, W.G. and Halpin, B.M., "Human Fatalities from Unwanted Fires," NBSGCR79168, sponsored by U.S. Department of Commerce, National Bureau of Standards, December 1978, issued April 1979.
2. "Fire Research on Cellular Plastics: The Final Report of the Products Research Committee," April 1980.
3. Birky, M. M., Paabo, M., Levin, B. C., Womble, S. E., Malek, D., "Development of Recommended Test Method for Toxicological Assessment of Inhaled Combustion Products," NBSIR 80-2077, National Bureau of Standards, September 1980.
4. ILE Report
5. Levin, B. C., Powell, A. J., Birky, M. M., Paabo, M., Stolte, A., Malek, D., "Further Development of a Test Method for the Assessment of the Acute Inhalation Toxicity of Combustion Products," NBSIR 82-2532, National Bureau of Standards, June 1982.
6. Snell, J. E., Levin, B. C., Powell, A. J., "Workshop on Combustion Product Toxicity Summary of Presentations, September 10, 1982," NBSIR 82-2634, National Bureau of Standards, November 1982, issued January 1983.
7. Snell, Jack E., "Hazard Assessment—Challenge to Fire Science," from "The Forum," Journal of Fire Sciences, Vol. 1, January/February 1983.

APPENDICES

- A. Center for Fire Research Brochure, March 1983.
- B. Center for Fire Research Long-Range Plan, November 12, 1983.
- C. Section 18, P.L. 93-498, Federal Fire Prevention and Control Act of 1974.

Available upon request.

JOHN W. LYONS

Date of Birth: November 5, 1930

Birthplace: Reading, Massachusetts

Education: Degrees

Harvard University, A.B., Chemistry
1952

Washington University, A.M., Physical Chemistry
1963

Washington University, Ph.D., Physical Chemistry
1964

Positions:

Acting Deputy Director
National Bureau of Standards

Dr. Lyons was appointed in April 1983 as Acting Deputy Director of the National Bureau of Standards. In this position, Dr. Lyons is responsible for the efficient execution of the Bureau's operational programs. He coordinates, monitors, and assesses progress of all NBS technical projects, and of the supporting services.

(NBS is the Nation's central reference laboratory, providing measurement methods, standards, and data that are used in industry, commerce, government, and universities. Bureau headquarters are located in Gaithersburg, Maryland, with a second laboratory at Boulder, Colorado. Total staff numbers about 3,200).

As Director of the National Engineering Laboratory from December 1977 until April 1983, Dr. Lyons was responsible for NBS's research in applied mathematics, building technology, electronics and electrical engineering, energy conservation, engineering standards development, fire, manufacturing engineering and chemical engineering.

Dr. Lyons was Director of the NBS Center for Fire Research until December 18, 1977, and was responsible for providing scientific and technical knowledge applicable to the prevention and control of fires.

Dr. Lyons served in various research and development positions at the Monsanto Company from 1955 to 1973. He specialized in the chemistry and uses of phosphorus-based chemicals including fire retardants. He served from 1971 to 1973 as a member of the ad hoc panel of fire research, a National Academy of Sciences evaluation panel for the National Bureau of Standards.

Dr. Lyons is author of two books: Viscosity and Flow Measurements and The Chemistry and Uses of Fire Retardants. He has contributed chapters to five other books and has written numerous papers and articles on technical or research topics. His early research interest was the physical chemistry of polyelectrolyte solutions, especially formation of complexes with metal ions. This work emphasized the behavior of inorganic polyphosphates and deoxy ribonucleic acid (DNA).

Dr. Lyons is a Fellow of the American Association for the Advancement of Science, Fellow of the Washington Academy of Science, member of the American Chemical Society (past chairman of the St. Louis Section), member of the American Institute of Chemical Engineers and member of Sigma Xi. He serves on the Advisory Committee for Engineering, National Science Foundation; Advisory Council, College of Engineering, University of Maryland; Board of Directors, National Fire Protection Association. He is serving on a special committee of the Maryland State Board for Higher Education to study the needs for engineering education. He was chairman of the Products Research Committee (1974-1979), a nine-member charitable trust administering a \$5M research fund on fire research; co-chairman of the US-Japan Natural Resources Panel of Fire Research (1975-1978). He received the Presidential Management Improvement Award in 1977 and the U.S. Department of Commerce Gold Medal, also in 1977. In 1981 he received the Presidential Rank Award of Distinguish Executive.

4/20/83



UNITED STATES DEPARTMENT OF COMMERCE
National Bureau of Standards
Washington, D.C. 20234
OFFICE OF THE DIRECTOR

August 10, 1983

Honorable Orrin G. Hatch
Chairman, Committee on Labor and
Human Resources
United States Senate
Washington, DC 20510

Dear Mr. Chairman:

Enclosed are the written answers to your additional questions on fire safety which you provided to me after the July 19 hearings before the Committee on Labor and Human Resources. It was my pleasure to appear before the Committee.

If you have any questions or need for additional information, please contact me or our Director of Congressional and Legislative Affairs Esther Cassidy at 921-2441.

Sincerely,

A handwritten signature in dark ink, appearing to read "John W. Lyons". The signature is fluid and cursive, with a long horizontal stroke at the end.

John W. Lyons
Acting Deputy Director

Enclosure

NATIONAL BUREAU OF STANDARDS

1. Q. Can you explain what is being done to protect the public from toxic combustion in buildings?

A. The most effective approach to protecting the public from toxic combustion products is to prevent fires, and many of the building and electrical code provisions are designed with that end in mind. Failing that, building codes are designed to minimize the chance of a major fire, that is, to prevent a small fire from rapid build-up and spread. The generation of toxic gas is a function of fire growth and spread. Limiting the size and extent of a fire limits the generation of toxic combustion products. In addition, early detection and warning provide more time for both escape and control of the fire. The widespread use of smoke detectors is helpful. The National Bureau of Standards is conducting research on how to measure the toxicity of combustion products and determining the effect of fire conditions on the degree of toxic hazard. A significant part of this research is on the development of a model that will integrate all the data and provide an assessment of the risk. While implementation is still a few years away, we are far closer than ever before.

2. Q. What new information or new tools might be needed to help in assessing risk in fires?

A. Assessment of risk from fire depends on an understanding of many factors. Some of these are the likelihood of ignition, the availability and type of fuel (furnishings), detection and warning devices, automatic suppression (sprinklers), smoke control, escape paths, mobility of occupants, etc. An understanding of the interactions of all these factors, as well, is required to assess risk. Presently, the assessment of risk is made by expert judgement in a rather subjective, and hence usually conservative and costly manner. The ability to assess risk quantitatively depends on the development of good, validated

models that take into account the various factors and their interactions. The Center for Fire Research (CFR) is devoting a significant effort to this end and is making substantial progress.

3. Q. Has NBS addressed the issue of relative toxicity among combustible materials?

A. NBS is addressing the question of how to measure the toxic effects of combustion products in a laboratory test and how to relate the results to actual fire situations. We have developed a test method suitable for use on small pieces of individual materials. Results to date show most commonly used materials produce combustion products in the test with roughly similar toxic effects in test animals. The test is not perfect; we are working on some refinements which will make it more flexible and the results applicable to more fire situations. The present test can be used by materials' manufacturers to study new materials to see if there are any unexpected effects which warrant special study or special care. We believe the uncertainties in the present test are such that only differences of about a factor of ten in test results for different materials are meaningful.

4. Q. Do you feel there is a reliable test that simulates the fire environment and can give an evaluation of the relative toxicity of the combustion products of a material under an acceptable fire environment? Please explain the test, how it works, and whether there is disagreement about its validity?

A. There is no single fire environment; rather, a near infinity of fire exposures are possible. The NBS measurement method in its present form simulates only two particular fire environments; we are working on a variant which would provide a few other exposures. When the additional exposures are incorporated in the test, relative toxicities in an "acceptable fire environment" could be evaluated.

The current NBS measurement method exposes a sample of the material to heat to decompose the sample under flaming and non-flaming conditions. The combustion products are held in a large chamber into which are introduced test animals (rats) for 30 minutes. The surviving test animals are then observed for 14 days after exposure. Analyses of gas concentrations in the test chamber during exposure and of the blood chemistry of the exposed animals are made. The simplest index of performance is the concentration of material in the atmosphere necessary to kill one-half of the test animals (LC50).

Animal exposure is necessary because there are too many chemical species among the combustion products and too many unknown interactions to predict the effect on human organisms from chemical analyses alone. The procedure outlined above is not unlike others used by toxicologists when dealing with such complex systems.

The NBS procedure evolved over ten years and was made into a test protocol with the participation of leading toxicologists in government, industry, and academe. The principal arguments about validity are: (1) that the test exposure represents only a few possible fire environments and (2) that only individual pieces of materials can be studied so that geometrical factors and interactions among different materials cannot be studied. These are valid concerns but do not in our opinion render the method useless. They do suggest that the test results be used by experts who understand the limitations.

5. Q. What are the major areas of research which are expected to be most fruitful from the viewpoint of improving fire safety?

A. Fire safety will be improved in the next two decades primarily by integrating knowledge we now have or are about to obtain into hazard assessment methods which can take into account all the key variables (see 2 above). NBS is working on three aspects of this problem: (1) completing development of a series of laboratory test methods to generate, primarily, fire properties of materials; (2) developing mathematical models of fire in a room and in a building; (3) developing a means to weigh and combine all the variables with the models

into a scheme for estimating escape time. We hope all of this will become available for designers, owners, code officials and the like and will be a user-friendly, computer-based system.

6. Q. What are the current and foreseeable capabilities of combustion product toxicity to measure a material's toxicity in a fire?

A. The present NBS toxicity test method has the potential to produce results which can be used to predict the toxic effects of the combustion products of a material in a fire. We have some additional work to complete on the combustion exposure before such predictions can be made with confidence. The test will always have the limitations of all fire tests, that is, we cannot run all possible fire exposures but only a few most likely ones.

7. Q. Within the scope of combustion product toxicity, what hazards are the greatest cause for concern?

A. There is no question that the greatest hazard in combustion products is caused by the presence of carbon monoxide. This gas, odorless and colorless and toxic at low to moderate levels, is produced when any organic material burns normally in air. All field data show that carbon monoxide is involved in every fatality caused by inhaling combustion products. Certain natural and synthetic polymers produce, on burning, additional gases which are also toxic at low to moderate levels. These are invariably accompanied by carbon monoxide. There is always the possibility that a new material might come into common use and produce a far more toxic gas. The NBS measurement approach will be most useful in guarding against this possibility. We hope industry will use it for just this purpose.

Senator QUAYLE. Thank you very much, Dr. Lyons.
Mr. Ellis.

STATEMENT OF WAYNE P. ELLIS, DIRECTOR OF STANDARDS, H. B. FULLER CO., AND CHAIRMAN, TOXICITY TASK FORCE, NATIONAL INSTITUTE OF BUILDING SCIENCES, ACCOMPANIED BY STEVEN BIEGEL, AIA, DIRECTOR, OFFICE OF PROGRAM PLANNING, NATIONAL INSTITUTE OF BUILDING SCIENCES

Mr. ELLIS. Thank you, Mr. Chairman.

My name is Wayne Ellis. I am the senior standards consultant for the H. B. Fuller Co., of St. Paul, Minn., but I am appearing here today on behalf of NIBS, the National Institute of Building Sciences. Also accompanying me is Steven L. Biege, AIA, of the NIBS staff. You have my prepared statement. This statement has been properly massaged by staff, and certainly represents my point of view and that of NIBS. In that statement you will find our response to the three specific questions that have been raised. However, I would like to make some general comments and then respond to your questions.

Each of the preceding speakers has summarized the problem very well. The problem of unwanted fire has been with mankind from the beginning. The problem of unwanted fires in buildings goes back at least to the Middle Ages, and in the intervening period innumerable studies have been made. Many, many individuals and organizations have addressed the problem and a vast bank of data and experience is available to those who are still seeking to get control of the fire problem.

The traditional fire safety systems involve three aspects: No. 1 is fire prevention. No. 2 is fire protection, that is, protection from fire; and No. 3 is fire suppression. Each one of the activities that we have heard about here this morning fits into one of those categories.

Now, the particular interest here this morning seems to center on the question of toxicity of the newer building materials. The toxicity of materials, that is, the smoke toxicity fits into the fire protection area, and as a number of speakers have said, smoke has been known to be toxic. What is new, then? What appears to be new is the heightened awareness on the part of the public. As Senator Hatch mentioned in his opening remarks, there have been some spectacular tall building fires, there have been some aircraft fires, and these have made the news and people are aware, then, that something may be different in the aspects of considering fire toxicity.

The problem really is that science and technology, that is fire science and technology, have not yet caught up with the answers to the problem of what to do about the newer materials which might be more toxic. In this respect the problem is no different from a number of other social-scientific problems we are faced with today, in which science has not yet caught up with public policy needs. You could look at the issues in the press these days—dioxin, acid rain, air pollution in buildings, you name it—these are all areas in which science has not yet provided answers which are badly needed so that public policy may be made and the public may be protected.

That, I think, is the perspective in which we need to look at the question of toxic materials in building fires.

In my opinion, no new legislative initiatives are needed to provide oversight on this problem. I don't think that any new regulatory action is needed to assist in the problem. I think that the answer to the problem, as a number of witnesses have pointed out, is the continuing cooperation and coordination between all of the interests who are looking at the problem and who are trying to do something about it.

The pace of research in fire technology, fire science and technology, has accelerated drastically in the last few years through the provision of computer assistance in addressing all of the complex factors that are involved in building fires. As Dr. Lyons has mentioned, fire modeling is a new science which is still in its infancy, and the National Bureau of Standards is doing a fantastic job along with others to rationalize this science and to provide to those authorities who must, through building codes and standards, provide for the public safety through rational decisions.

The building code community, supported by the standards community, has been doing an excellent job in protecting the public health and welfare with respect to building fires. We have to recall that the State and local code official who is faced every day with the problems of what construction to approve, what materials to release, has to keep his nose to the grindstone so he may not be informed as to all of the research and all the new ideas that are current in the total fire protection community.

It is one of the roles of NIBS, the National Institute of Building Sciences, to interface between building codes and standards officials and the scientific community. I think NIBS is uniquely qualified to do this because NIBS is a federally chartered institution that brings together all interests in the building community, and it has already demonstrated through its consultative counsel much expertise and knowledge of all of the varied interests that can be brought together to bear on the solution to problems.

Therefore, I would suggest, Mr. Chairman and Senator Randolph, that NIBS be considered as part of the cooperative effort that needs to be continued in order to solve the problem of building fires and toxicity in building fires.

Thank you very much.

[The prepared statement and responses of Mr. Ellis to questions submitted by Senator Hatch follow:]

A Statement By:

Wayne P. Ellis

on behalf of

The National Institute of Building Sciences

on

Fire Safety in Buildings

Mr. Chairman, members of the committee, my name is Wayne P. Ellis. I am senior standards consultant to the H.B. Fuller Company of St. Paul, Minnesota. My responsibilities there include the monitoring of all design and construction standards, including fire standards, that impact our building product line. I am a past chairman of the board of the American Society for Testing and Materials, (ASTM), and a long time member of ASTM Committee E-5 on Fire Standards, as well as a member of the ASTM E-5 Subcommittee on Smoke and Combustion Products. My appearance before you today is on behalf of the National Institute of Building Sciences (NIBS), a Congressionally authorized body charged with bringing about a more rational building regulatory environment in this country. In 1982, I chaired a Task Force on "Toxicity Effects Resulting from Fires in Buildings" organized and sponsored by NIBS. Consistent with the NIBS authorizing legislation (P.L. 93-383, Section 809), the Task Force undertook to explore the significance of the fire toxicity problem and its relationship to modern day building codes and standards. The member of the NIBS staff responsible for compiling the reference materials upon which our findings were based is here with me today. Mr. Steven L. Biegel, AIA, is a registered architect and the Director of Program Planning for NIBS.

Attached to my formal statement is a copy of the NIBS' Task Force State-of-the-Art Report on Toxicity Effects Resulting from Fires in Buildings (May 16, 1983). This document summarizes the building

communities' views on the relationship between toxicity, as a cause of death and injury in building fires, and building codes as the vehicles by which public health and safety is protected in most jurisdictions throughout the nation. Representatives from nearly 100 major building related organizations participated with us as we attempted to sort out the issues and to determine a recommended course of future action. Each member of this Senate committee was sent a copy of the report shortly after its publication in May of this year. Additional copies were sent to every governor and the mayors of the fifty largest cities.

In the interest of time, I will not attempt to quote sections of the report. Instead I will respond directly to the three questions contained in the letter of invitation and ask that the complete NIBS Toxicity report be made part of the hearing record.

- What are the causes of fires and the causes of the mortality and injury from them?

Based upon the documents we have reviewed from a variety of prominent sources, including the Fire Academy and the National Fire Protection Association, a substantial number of building fires: a) occur in residences--usually in rural areas; b) have a burning cigarette as the source of origin; c) involve bedding or upholstered furniture as the initial fuel source. Page 5 of the NIBS report contains a table reproduced from the September 1979 issue of NFPA's Fire Journal listing 18 common fire scenarios resulting in mortality. These statistics are reconfirmed by an article in the July 1983 Fire Journal on "1982 Multiple Death Fires in the U.S."

It is widely recognized that incapacitation and death in building fires are the result of smoke inhalation, not exposure to flame. Most toxicologists will agree that carbon monoxide is the largest single

contributor to injury and death from inhalation of smoke present during building fires. What is extremely difficult to establish is the nature of other chemicals and compounds and their specific physiological affect on those exposed. As members of the medical profession will tell you, the effect of carbon monoxide inhalation can be identified in the blood of fire victims. Identification of other chemical compounds is extremely difficult, even by autopsy, because body tissue and other chemicals within the body absorb or react with toxic agents.

- What are your recommendations for eliminating the causes of fires and reducing mortality and injury?

The recommendations of the National Institute of Building Sciences are summarized on page 12 of the attached report. With the knowledge that as many as 8,000 people die in a single year in building fires and in view of the fact that the causes of most of these fires are the result of acts controllable only by the victim or his associates, i.e. smoking, cooking, improper use or storage of flammable materials, an expanded program of public education aimed at home owners and occupants holds the most promise for reducing the number of deaths and injuries.

In the limited number of cases where a real public risk has been identified and multiple fire deaths occur, e.g. hotels, motels, schools, hospitals and other public buildings, requiring the installation of smoke detectors is recommended. This measure does not alter the fact that fires will continue to be caused by careless smoking, arson, and perhaps by equipment malfunction, but it provides early warning of a fire condition and makes possible an escape from a potentially toxic environment.

- To what extent is toxicity a major problem in fires and what can be done about toxicity?

All smoke is toxic to a greater or lesser degree. The NIBS Toxicity

Task Force accepted the premise that any chemical imbalance in the normal percentage of nitrogen/oxygen that is breathable air would be considered toxic. Prolonged exposure to a chemical imbalance in breathable air will produce physiological side effects. I am not a physician and I will not attempt to explain the vast range of disorders that might result. Suffice it to say that all smoke is toxic and the more smoke density that is present in a habitable space, the greater the risk to the occupants of that space.

Very little can be done about toxicity itself, short of eliminating all combustible materials from buildings. When something burns, smoke will be emitted and a toxic environment will result. One obvious course of action, then, is to prevent a fire from occurring in the first place. However, because eliminating all fires is not realistic, the threat of fire to the public must still be dealt with. Steps have already been taken to minimize this threat to the public by the introduction into building codes of many common sense restrictions and procedures. For example, provisions already exist in modern day building codes for fire separators, structural insulation, fire exit hardware, fire extinguishers, sprinklers, special construction in exit corridors, fire alarm systems, fire doors and fire escapes. Building code authorities, in reviewing building plans and fire control construction, examine the physical features of the building with regard to evacuation of the occupants during an emergency. This is a very serious and rigorous practice.

It should be understood by members of this committee that building codes are intended to help protect the public from foreseeable risks in normal use of a building. As such, building codes and code authorities cannot wholly prevent fires. However, they are intended to assure adequate safeguards and

adequate means of egress under the presumption that a fire may occur at some time in the future under whatever circumstances might prevail.

Another point that must be understood is that a building code is intended primarily to protect public health and safety. For example, the building code can have no impact on the smoking habits of individuals in the privacy of their own home. Individual safety is largely a personal matter. Public safety is much different and is the underlying concern from which most building code provisions are written and enforced.

Mr. Chairman, members of the committee, I urge you to consider the recommendations contained on page 12 of our report in your deliberations including those for research by federal agencies.

In my view, at this time there are two critically important needs; a need for expanded public education, and; a need for voluntary guidelines for materials and for risk assessment guidance for design professionals and code authorities. The National Institute of Building Sciences proposes to work with all parties of interest in the public and private sectors of the building community in the development of technical guidelines on these subjects. I hope this committee will support this approach, so that efforts to reduce the risk and damage of fire and smoke in buildings can move ahead expeditiously.

Thank you for the opportunity to present these views. We will be happy to respond to any further questions you may have.

Toxicity Effects Resulting from Fires in Buildings

State-of-the-Art Report

May 16, 1983



National Institute of
BUILDING SCIENCES

Letter from the Board

May 16, 1983

The Board of Directors of the National Institute of Building Sciences extends its sincere appreciation to the many experts who participated in the development of this report. In particular, the Board recognizes the contribution of Wayne P. Ellis, Chairman of the Task Force charged with conducting this investigation.

This report, *Toxicity Effects Resulting from Fires in Buildings*, summarizes the state-of-the-art of a complex and expanding science. Clearly, work must continue toward the development of acceptable toxicity test methods that will produce data useful to fire hazard assessment models. Eventually, standards may be established by which product manufacturers, design professionals, code authorities, and the general public may better interpret the fire and smoke risk posed by the man-made environment. Today, absent a scientific basis for such standards, attention must be directed to public education programs and to the prevention of fire in the home and the workplace.

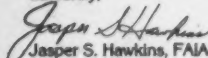
The primary charge to the Task Force was the conduct of a study to evaluate the need for a standardized toxicity test method in building codes. Many contemporary research reports were reviewed by the Task Force and the NIBS staff in response to this charge. Key to the investigation was an understanding of current fire safety measures already incorporated into modern building codes and the fact that every fire situation differs. In the opinion of the board, the Task Force addressed the relevant issues in a timely and professional manner.

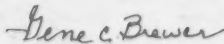
The NIBS' Board concurs with the recommendations presented by the Task Force in this report. In addition, the Board wishes to express its intent to cooperate with professional societies and other organizations, such as the National Fire Protection Association and the nationally recognized Model Codes, toward the accomplishment of these recommendations and the attainment of greater fire and smoke safety in buildings. Steps should be taken immediately to provide reliable information to design professionals, regulatory authorities, and the general public. It is the further recommendation of the NIBS' Board of Directors that state and local officials be advised that current tests for toxicity of products of combustion are inadequate for regulatory purposes.

It should be recognized that building codes do not control the furnishings of a building nor can they address occupant behavior. However, the advent of smoke detectors and the evolution of smoke containment/compartmentalization systems in building codes have added measurably to the safety of occupants and the protection of property. Considerable reductions in the loss of life and property have already been achieved and more can be accomplished by strict adherence to existing codes and the use of appropriate design techniques.

This state-of-the-art report represents a consensus view of the toxicity in building fires situation. The Board is grateful to the many members of the building community who, in reviewing and analyzing the vast quantity of information on this subject have performed a valuable public service.

Sincerely,


Jasper S. Hawkins, FAIA
Chairman of the Board


Gene C. Brewer
President

Toxicity Effects Resulting from Fires in Buildings

Introduction

In recognition of the widespread public concern for the potential life threatening effects of smoke emitted when materials and furnishings in houses and other buildings burn, the National Institute of Building Sciences (NIBS) undertook to evaluate the significance of the problem and its relationship to modern day building codes and standards. The premise was accepted that every fire situation involves a different set of toxicology circumstances with regard to fire related deaths. Recognizing that the United States and Canada have higher fire fatality rates (per million population) than other industrialized countries and with the knowledge that thousands of people are injured and killed each year due to fires in buildings, the NIBS Board of Directors authorized a special Task Force to explore the impact on building codes of current technology with respect to toxicity of combustion products in building fires. That portion of the NIBS authorizing legislation (Sec. 809 of P.L. 93-383) wherein the Institute is charged with evaluating current and new technology and advising Federal, state, and local governments with respect to the inclusion of technical provisions in building codes was the impetus for undertaking the project. It has been noted that some state and municipal governments are taking steps to incorporate toxicity test methods and materials toxicity criteria into state and local building codes. The traditional responsibility of state and local government is the protection of public health and safety. The states of New York and California have enacted measures to require assessment of various toxicity test methods.

The NIBS Task Force was specifically charged with conducting a study to evaluate the need for a standardized toxicity test method in building codes, and with establishing the parameters of its use in codes if such a need exists. Ancillary to this major task were the following charges to the Task Force:

- a. determine the severity of the problem of the number of deaths resulting from toxicity in fires;
- b. determine what past and current research has been or is being conducted on toxicity in products of combustion;
- c. determine what parameters have been used to define the research conducted;
- d. determine the significance and validity of the research results to date;
- e. if toxicity requirements or limits are included in building codes, suggest methods of enforcement and levels of training required.

During the initial meetings of the Task Force, it was determined that the broad range of tasks assigned by the Board needed to be narrowed in the interest of time and available resources. Therefore, the Task Force confined its work to the following items:

- a. review the severity of fire injuries and the number of deaths caused by exposure to toxic gases from building fires;
- b. determine what past and current research studies and data are available on toxic effects of smoke in building fires;
- c. determine what parameters have been used to define the research conducted;
- d. evaluate the significance and validity of the research results to date.

On August 2, 1982, a major meeting of fire experts was convened at the National Housing Center in Washington, D.C. Presentations were made to describe the current status of work related to the tasks listed above. In addition to the charge given to the Task Force, key questions were asked and a discussion ensued on the need for and utility of toxicity restrictions or criteria as part of a building regulatory system. The questions put forth included:

1. How serious is the problem of toxic smoke from materials in building fires?
2. How effective are the building codes and fire codes in minimizing toxic smoke hazards?
3. What is being done to protect the public from toxic combustion products in buildings?
4. What technical data or test methods exist?
5. What new information or new tools might be needed to help in assessing risk in building fires?

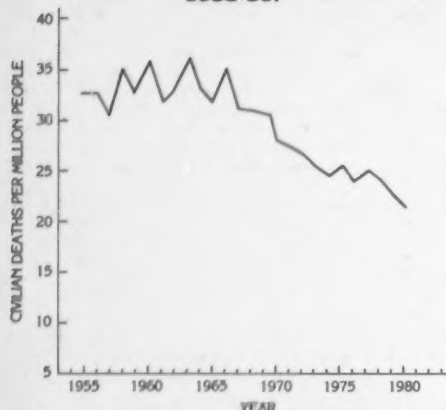
This report addresses each of these questions and identifies the significant issues relative to smoke toxicity measurement and the utility of information derived from material testing. Section 6 summarizes needs and recommendations determined by the Task Force. The Task Force has attempted to confine the scope of this investigation to the relationship of smoke to the overall building fire problem and to the role of building codes; their content and enforcement.

In addition to the members of the Task Force who contributed substantial amounts of time and expertise, the National Institute of Building Sciences acknowledges the contribution of technical reports, literature, scientific data and comments from over fifty organizations. A list of the participating organizations appears in Appendix A of this report.

1.0 How serious is the problem of toxic smoke from materials in building fires?

According to data available from the U.S. Fire Administration, it is estimated that approximately 8,000 fire fatalities occur annually in the United States. Injuries are inflicted upon an additional 31,000 individuals and some sources claim as many as 250,000 unreported fire accidents occur each year that cause personal injury. The direct dollar loss resulting from fire damage to property exceeds 5 billion dollars annually. Most fire deaths occur in residential structures. About 80% of such deaths are due to the inhalation of smoke. Smoke is defined as "the airborne solid and liquid particulates and gases evolved when a material undergoes pyrolysis or combustion," (ASTM Definition). Therefore, when referenced in this report, the term smoke includes toxic gases and is an all inclusive term. According to the National Fire Protection Association, the U.S. Fire Administration, the National Bureau of Standards, and others, smoke has been found to be the most significant threat to human life during combustion of buildings and their contents. Repeated exposure to smoke and heat also poses a series of life-threatening circumstances, some of which may not become apparent for months or years following such incidents.

TABLE 1
Civilian deaths per million people from fire and flame in the home in the United States, 1955-80.



(Source of fire fatalities: National Safety Council, whose estimates are based on data from National Center for Health Statistics and state health departments. Source of population figures: U.S. Census Bureau.)

In the United States, the frequency of fires resulting in personal injury or death has declined over the years. Table 1 illustrates the fact that in 1955 civilian deaths from fire related incidents in the home were approximately 33 per million people. In 1980, statistics indicate that approximately 20 people per million suffered fatal injuries from smoke and fire in the home.

Additional data published by the National Fire Protection Association estimates that civilian fire fatalities number approximately 6,500 annually. Table 2 sets forth statistical data on the magnitude of the fire death and injury problem for selected property-use categories.

TABLE 2
Fire Death & Injury Statistics

Property Use	Death		Injuries	
	Estimate	%	Estimate	%
One and Two Family Dwellings*	4,175	64.2	16,100	53.3
Apartments	1,025	15.7	3,600	11.9
Hotel & Motel	165	2.5	1,075	3.6
Other Residential	81	1.3	325	1.1
Total Residential	5,446	83.7	21,100	69.9
Non-Residential Structures	229	3.5	3,625	12.0
All Other**	830	12.8	5,475	18.1
Grand Total	6,500	100.0	30,200	100.0

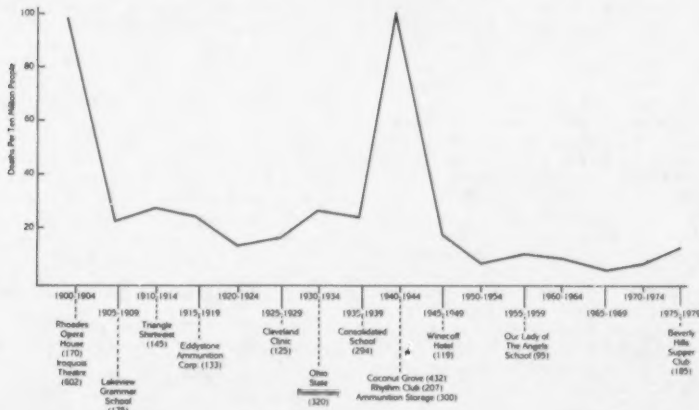
*including mobile homes

**includes vehicle fires and other non-building fires

(Source: NFPA Fire Journal, "Fire Loss in the United States During 1980," by M. J. Karter, Jr., September 1981.)

Since the turn of the century, the frequency of major building fires in the United States has been decreasing. Of the twenty worst U.S. fire disasters in this century, three have occurred since 1950—the most recent of these being the MGM Grand Hotel fire in 1981. Other major building fires involving the loss of at least 25 lives are identified in Table 3.

TABLE 3
Major Loss of Life in 20th Century U.S. Building Fires Taking at Least 25 Lives



The fire death rate for the United States is very high, many times that of most industrialized nations. This comparison is the basis for most concerns about the toxicity hazard in fires implying that the high fire death rate in the U.S. is due to the toxic combustion products of man-made materials.

Fatality rates, expressed as number of deaths per million people, may be misleading. An alternative measure of the seriousness of the U.S. fire problem can be expressed as number of deaths per 1,000 fires. Taken either way, the severity of the U.S. fire death situation compared to those in Great Britain, Austria, France, and Switzerland is great. Table 4 illustrates this comparison.

TABLE 4

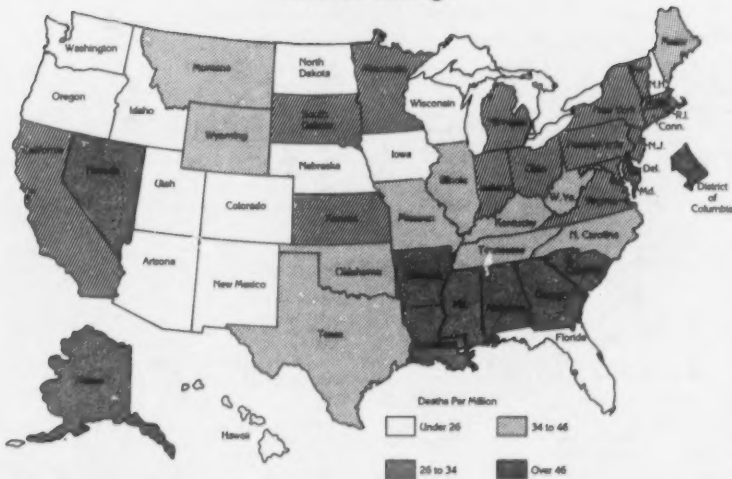
	Fire Death Rates* per	
	Million Population	Thousand Fires
Great Britain	18	3.4
Austria	10	3.3
U.S.A.	24	2.6
France	5	2.3
Switzerland	4	2.2

*Based upon average 1978, 1979 and 1980 data.

Although cause profiles for residential fire deaths in the United States vary from state to state, it has been determined that fires associated with space heating, cooking, and smoking pose the most significant threat for residential occupants. It also has been shown that the southeastern region of the country has the highest death rate, and that one factor accounting for this is the predominately rural living situation. Dwellings in rural areas are inherently scattered and mostly protected by small, volunteer fire departments with limited resources. Impoverished areas, rural and urban, seem to suffer a higher incidence of fatal fire conditions for many reasons, among which may be living conditions, equipment, age of buildings, etc.

The response time of the fire department and the equipment used to combat a fire are important variables in attempting to determine the significance of location to fire death and injury data. Statistics show that the incidence of fire fatalities is greater in rural than in urban areas. However, the precious few minutes after ignition are crucial no matter where the location of the fire. The best equipped fire departments may not respond fast enough to prevent death or serious injury. Table 5 illustrates the regional breakdown of fire deaths, based upon 1979-80 data.

**U.S. Fire Death Rate
1979-80 Average**



Source: U.S. Fire Administration

Recent studies and reports produced by Factory Mutual System, Underwriters' Laboratories, and the British Standards Institution, suggest that smoke can move rapidly, depending upon the building configuration, location of vertical shafts, stairs, elevators, and type of air-handling system, from the room of origin to other parts of the building, threatening other occupants. Such movement of smoke has occurred in locations remote from the source of the fire. The primary toxic agent produced in such fires is carbon monoxide. Other toxic agents that may be present include hydrogen cyanide, hydrogen chloride, sulphur dioxide, acrolein, aldehydes, carbon dioxide, and a variety of airborne particulates carrying heavy metals, e.g., antimony, zinc, chromium and lead. Autopsy data are vague on the relationship of these elements to death. Even if the identification of many of these agents in blood or in the lungs of fire victims were possible, the determination of precisely which compound or combination of chemical agents is responsible for death is

extremely difficult. This finding is supported by recent studies conducted by Southwest Research Institute, the National Fire Protection Association, and the Center for Environmental and Materials Research.

It has been recognized that the materials involved in a fire may include the total building, structure and contents. Fire gases are evolved from burning building products, furniture and surface coverings, books, papers, clothing, and a wide range of personal effects. The significance of time of human exposure is the fact that brief exposure to a highly toxic environment may be survived, while a lengthy exposure to a moderately toxic environment may lead to incapacitation, narcosis, or death. Thus, it has been determined that early warning systems such as smoke detectors, can be a significant factor in enhancing life safety.

There is a general agreement among researchers and within material testing laboratories that a fire is a sequence of complex dynamic processes and that a unique set of time and temperature conditions exist in every fire. It has been

TABLE 6
Leading Ignition Scenarios for One- and Two-Fatality United States Fires, 1971-1978

Both Accidental and Incendiary and Suspicious Fires Are Included
 (out of 780 distinct scenarios, 52.6 percent of the deaths
 were concentrated in the 18 scenarios listed below)

Heat of Ignition	Material Ignited	Area of Origin	% of Deaths	% of Fires
Cigarette	Upholstered furniture	Living area	17.3	16.9
Cigarette	Bedding	Sleeping area	14.7	15.5
Highway motor vehicle crash	Fuel	Vehicle fuel tank	3.9	3.7
Match, lighter, candle	Bedding	Sleeping area	2.3	2.2
Heating, cooking equipment	Structural component	Living area	1.7	1.5
Cooking equipment	Clothes on a person	Kitchen	1.5	1.8
Cooking equipment	Cooking materials	Kitchen	1.4	1.6
Cigarette	Upholstered furniture	Sleeping area	1.4	1.4
Heating, cooking equipment	Fuel	Kitchen	1.2	1.3
Highway motor vehicle crash	Gasoline, Lp-Gas	Truck cargo area	1.1	1.1*
Cigarette	Bedding	Living area	0.9	0.9
Heating, cooking equipment	Fuel	Living area	0.8	0.9
Match, lighter, candle	Upholstered furniture	Living area	0.8	0.7
Match, lighter, candle	Soft goods other than bedding or clothes on a person	Sleeping area	0.8	0.7
Match, lighter, candle	Clothes on a person	Sleeping area	0.7	0.8
Cigarette	Clothes on a person	Sleeping area	0.7	0.8
Heating equipment	Fuel	Heating equipment area	0.7	0.7
Match, lighter, candle	Fuel	Living area	0.7	0.6

Based on 5,405 civilian deaths in 4,493 one- and two-family fires with known ignition scenarios in NFPA FIDO data.

All percents in this Table refer to this data set.

Out of 780 distinct scenarios in this data set, the 18 scenarios in this Table accounted for 52.6 percent of the deaths and 53.1 percent of the fires.

*The fires in this scenario are generally dramatic and are particularly well reported. For this reason, it is possible that the scenario is over-represented in the data. Further research will clarify this question.

This Table is reproduced from the Sept. 1979 issue of NFPA's FIRE JOURNAL article "Fatal Fires in America," by Dr. Louis Deery

learned, however, that fire dynamics are characterized by common sequences of events such as ignition, flame spread and heat generation. Even though every fire is unique, defending against serious fires in buildings entails the development of systems to control one or more aspects of the fire sequence. Much work has been done in an attempt to correlate ignition scenarios with fire mortality rates. One such study conducted by the National Fire Protection Association presented data on 18 distinct fire scenarios based upon investigation of 780 accidental, incendiary and suspicious fires. This information is summarized in Table 6.

The human physiological response to smoke inhalation is of at least two types—the immediate, which is manifested in a matter of minutes reducing the chance of escape—and the latent, which may not become apparent for hours, days, months or years. Attitudinal surveys have shown that the average person expects never to be exposed to fire gases and thus has little interest in self-protection measures. In reality, a great many unreported fires do occur in homes. Short-term exposures to small fires may be of the order of only a

few minutes, but rapid build-up to a flashover condition is a real danger. Studies have shown that occupants of one and two family residences have less than five minutes (on the average) after flashover, to make their escape. This assumes that they are not in the room of origin at flashover. It should be noted that little research has been conducted to determine the effects of repeated, short-term exposure. Some information has been derived from studies of Baltimore, Maryland, and Washington, D.C., fire departments. Such information is proving extremely useful to firefighters.

It has been recognized that no single interest group can achieve a universally acceptable solution to the fire problem in the United States. The diversity and segmentation of the building community in this country makes difficult the task of advancing new technologies and fire control measures. Yet, it is widely recognized that the problem of smoke generation and control is an extremely serious one requiring both immediate and long-term remedies. In the following pages, several of these potential solutions are presented in response to the charge of the Task Force.

2.0 How effective are the buildings codes and fire codes in minimizing toxic smoke hazards?

By and large, building codes are accomplishing a great deal in the area of fire and smoke protection. Most building codes contain provisions for fire alarm systems (including detection and signaling), fire doors, fire escapes, fire exit hardware, fire extinguishers, fire separators, and exit corridors. Building code authorities, in reviewing building plans and fire control construction, examine the physical features of the building with regard to how they might influence evacuation of the occupants during an emergency.

2.1 Code Rationale

Fire protection provisions in contemporary building codes exist for the following reasons in order of importance:

1. to provide for the safety of occupants of buildings and to make provision for their evacuation or refuge during a fire;
2. to provide for the safety of firefighters;
3. to provide for the safety of adjoining property and to prevent the spread of fire; and
4. to provide for the preservation of the property.

The building code does not control the furnishings, many types of surface finishes, or the behavior of the occupants, e.g., cigarette smoking. Therefore, the code cannot be singled out as the culprit in such fire related deaths.

Modifications to building codes have resulted from fire experiences involving significant loss of life or property. Such code changes usually are not retroactive to cover existing construction. Fire incident reporting systems present data identifying the involvement of specific building products and materials and construction details that affect the growth and spread of fire. It is clear from these data and information available from the National Fire Protection Association that if and when a life-threatening fire occurs in a public building, some code-related problem has occurred, e.g., incorrect application of fire test data, construction inspection, or code enforcement or unregulated owner modification after building occupancy.

Causes of fire and smoke spread may vary, from design or construction errors and omissions to owner-initiated modifications of either the interior layout or the building systems, or any combination of the above. The frequency of fire hazards may be directly related to a lack of adequate inspection during construction. Evidence has shown that in most multi-death fire cases in commercial or public buildings, some aspect of the building code has been violated prior to the development of a fire situation.

Building codes cannot guarantee that a fire will not develop. Arson, careless smoking, material and equipment failure, and a broad range of unpredictable circumstances involving

human judgment all may contribute to the cause of a serious fire. Codes are intended to minimize the risk to life and property under the assumption that a fire may occur.

2.2 Occupant Evacuation

Evidence indicates that most fire deaths which occur in buildings are the result of smoke inhalation, not exposure to flames. The National Fire Protection Association, in a well-known study of 500 typical fires, concluded that 62 percent of the fatalities were directly attributable to asphyxiation or anoxia caused by inhalation of smoke or oxygen depletion.

Protection and removal of building occupants is always the immediate concern. The degree of life hazard increases over time as smoke accumulates during smoldering and flaming combustion cycles. The speed with which evacuation can be accomplished depends significantly on the training of the occupants, the configuration of the building, the distance occupants must travel to reach the exit, and the effectiveness of the fire signaling and annunciation system.

2.3 Code Provisions

Traditionally, building codes have set exit requirements that directly affect the safety of building occupants during a fire emergency. Underlying the exit requirements are assumptions about how quickly a fire or smoke problem will develop and the condition of the people within the space (sleeping or awake). Exit requirements for a particular building usually are established with consideration for the assumed number of occupants and an assumed density in square feet per person. Density figures will vary by occupancy classification. Number of exits required is thus a function of the type of facility, number of occupants, and a reasonable period of time (distance) to the exit location. Exit stairs are usually sized based upon the per floor occupancy.

Codes also prescribe the type of building construction and fire resistive characteristics along the exitway. Provisions are made for protecting the flow of traffic along an exit corridor from heat and flame occurring in other portions of the building. Generally, a minimum width of exitway and reduced flame spread is prescribed for floor, wall and ceiling coverings in exitways. The code also contains detailed regulations for exit doors, door hardware, stairs, ramps, escalators, handrails and guards. All model building codes, including the Life Safety Code of the National Fire Protection Association, NFPA 101, contain design requirements for vertical openings, automatic detection and signaling systems, and automatic fire suppression systems. For example, the Basic Building Code (1981 Edition), section 1702, specifically identifies when and where fire suppression systems

are required. This is true of the Standard and Uniform Building Codes as well.

The significant beneficial effect of smoke detectors, particularly in residential buildings, should be recognized. Statistics available from the U.S. Fire Administration, for instance, show there are no known deaths due to fire in mobile homes where an operable smoke detector was present. Clearly, early warning is a major defense against fire.

2.4 Control of Toxic Smoke Emission

Previous code requirements covering toxicity held that a combustible material may be considered for use in the interior of buildings if it is an ordinary combustible which does not produce excessive quantities of smoke or products of decomposition more toxic than those of wood or paper. Statements such as "shall be no more toxic than wood" were used in model building codes prior to 1976. In 1976, it was recognized that such statements were meaningless in view of the minimal information available on the toxic nature of the combustion products of wood. It was also realized that no test method permitted accurate comparison of data on combustion products of wood.

Building code and fire authorities recognize that there is a relationship between the nature and amount of combustible contents and potential fire severity in a building. Such "fire load" characteristics are predicated on the fact that every pound of fuel in the building (including building material) might contribute to potential fire severity. Certain common building materials produce vastly greater amounts of heat and smoke per pound than others. This fact must also be considered in evaluating the potential toxic threat.

Surveys conducted by the National Bureau of Standards indicate that fire load assessment, based upon the total amount of combustibles within a space, is a partial measure of the "risk" or potential hazard presented by the particular space. NBS has also determined that the building height, age, and location are not significant factors in assessing fire load magnitude.

A remaining but vague requirement concerning toxicity is contained in the NFPA Life Safety Code stating, "any interior finish material shown by test to present an unreasonable life hazard due to the character of the products of decomposition shall be used only with the approval of the authority having jurisdiction." Such provision offers no reference to any particular test method and no criteria for what is an unreasonable life hazard.

Although other contemporary model building codes no longer contain provisions for limiting toxic combustion products, it is widely accepted that smoke detracts from the

occupants' ability to make rational decisions in an emergency. In addition, smoke generated by decomposing materials obscures vision and contributes to the likelihood of injury.

2.5 Smoke Movement

New smoke control techniques have been developed in this country, many European countries, and Japan. Such techniques are currently required in the design of larger health care, multi-family residential and high rise office buildings and many include automatic venting, detector-triggered barrier doors, pressurized stairways, temporary areas of refuge, and other design features. The vast majority of older existing high rise structures do not make use of such systems.

Relief from the smoke hazard can also be controlled by occupants if certain principles are recognized. Since heat, gases, and smoke tend to rise and escape through openings in the top of a space, fresh air may be entering the space at lower elevations. A person trapped in an enclosed space during the generation of heat and smoke in other parts of a building should be sure that his entrance door and any other corridor openings are tightly closed.

The possibility of confining smoke by various means to the space where it is generated is the subject of detailed investigation at many testing laboratories and by the ASTM Committee E-5 on Fire Standards. It has been recognized that smoke generated at elevated temperatures reacts in a manner different from "cool" smoke. Expansion of air, in the case of "hot" smoke, will cause pressure increases resulting in the forced flow of smoke through cracks around door and window openings. Cooler smoke may be easier to control by natural or forced ventilation techniques.

The use of air conditioning and heating systems in fire situations has not been thoroughly studied. The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) together with the National Bureau of Standards are developing guidelines for design professionals dealing with smoke movement. The planned pressurization of corridors and compartments along with the proper use of smoke stops, smoke doors, and automatically actuated dampers in air conditioning and heating ducts may provide a means for confining the fire and controlling smoke movement. The National Fire Protection Association, ASTM and others are considering the range of options for more effective control of smoke in burning buildings.

3.0 What is being done to protect the public from toxic combustion products in buildings?

3.1 Materials Testing

Public protection from fire and smoke has been a serious concern of building code and regulatory authorities for decades. Steps have been taken by many organizations and regulatory bodies to provide better information on fire and smoke control and to assure some degree of safety during the evacuation of burning buildings. Extensive state-of-the-art studies have been performed under the sponsorship of various government agencies, private corporations, and independent foundations on the subject of toxicity testing. Recent studies include: *An Analysis of Current Knowledge in Toxicity of the Products of Combustion*, by Benjamin/Clarke Associates, Inc.; *A Critical Review of the State-of-the-Art of Combustion Toxicology*, by Southwest Research Institute; and *The Control of Smoke in Building Fires—A State-of-the-Art Review*, by the American Society for Testing Materials (ASTM), Committee E-5. These and other pertinent documents are referenced in Appendix B of this report.

Several test methods are being developed for evaluating the toxicity of pyrolysis and combustion products of various materials and are being considered through the ASTM consensus process. In other countries, other test methods are being developed and considered by standards setting organizations. Laboratory test methods are being developed which can be used to rank the relative toxicity of the combustion products of materials, under specific laboratory conditions. It is recognized that the toxicity characteristics of a material are specific to the conditions of the toxicity test. Evaluating fire scenarios in general is extremely complex and may not produce information relevant to a specific fire scenario. Few of the evolving test methods (protocols) address this fact. Experimental systems are being developed whereby toxicity measurements in a controlled test environment, under both flaming combustion and non-flaming pyrolysis modes, can be made. Analytical and biological measurements are providing the basis for an improved understanding of toxicants and their potential lethality and physiological effects. Progress is being made in relating the results of such measurements to the potential fire risk associated with the use of a material in a specific application. However, it will be several years before tests are sufficiently developed to produce data that is useful to many audiences.

3.2 Risk Analysis

It is clear from the information made available to the Task Force that the control of materials alone or any other simple fire protection measure cannot provide effective control of

the toxic threat in building fires. It is widely recognized that additional factors such as the quantity of material present, its configuration and location, the proximity of other combustibles, the volume of the compartments to which the combustion products may spread, the ventilation conditions, ignition and combustion properties of the material(s) present, the presence of potential ignition sources, fire protection systems, and building occupancy, are important and must be considered in evaluating the toxic hazard posed by the use of a material in a given situation. As of today, however, there is no generally accepted methodology for performing such a hazard assessment.

Much progress has been made in recent years in developing mathematical models which can predict fire behavior in specific situations. The development of high capacity computers makes the application of such models practical, but they have not yet reached a stage of development where they can be applied routinely to fire risk assessment. These models make use of the fire properties of the materials in the fire system, including the toxic properties of their combustion products. The availability of reliable and consistent data on the toxicity properties of combustion products is a necessary input to any toxic hazard assessment. Such data is presently lacking. The development of toxicity test methods and the development of hazard assessment methodologies must proceed in concert to provide designers, builders and regulatory officials with the tools to reduce the threat from toxic products in building fires. The concentration of toxicants, the relationships of chemicals acting and reacting during varying time-temperature scenarios, and the potential lethality of a specific situation are most difficult to predict or determine. The variable nature of fires provides a motivation for developing improved fire models.

3.3 Other Measures

A number of approaches have been cited as major means for reducing fire death rates. The most commonly mentioned need other than those relating to fire suppression, is for more effective public education. Emphasis also is placed on improving means of fire detection, smoke control, and evacuation. The National Fire Protection Association's public education program known as "Learn not to burn" has been cited as a highly successful effort to provide citizens with essential information on building evacuation and the characteristics of smoke and heat generation.

4.0 What technical data or test methods exist?

4.1 Intoxication Syndrome

When a material is decomposed by a process of pyrolysis or combustion, smoke is produced. Smoke is a dynamically changing mixture comprised of many degradation products in the form of gases, aerosols, and other particulates. The changing nature of smoke presents a significant problem to those interested in the evaluation of animal or human response to such a complex mixture of toxicants.

It is difficult, if not impossible, to establish whether the "intoxication syndrome" (the signs and symptoms of intoxication consistently produced on exposure to the combustion products from a given material or combination of materials) develops as a consequence of one, some, or all of the substances present in the smoke. Since both quantitative and qualitative changes in combustion products occur when the mode of decomposition is changed (flaming versus

nonflaming combustion, level of heat flux, physical configuration, etc.) the "intoxication syndrome" is also expected to vary with these parameters.

4.2 Smoke Composition

Smoke from all fires will contain gases which are noxious and/or toxic. Exposure, even for short periods of time, to smoke may produce abnormal behavior in humans, result in incapacitation and, thus, prevent escape from the fire environment, or have fatal results depending upon the toxicants present, their concentration, and the human's physiological condition at the time of exposure.

Carbon monoxide (CO) is always found in the smoke produced during building fires. The presence of carbon monoxide has been identified during many post-mortem examinations, as having been present in lethal concentrations by analysis of blood carboxyhemoglobin levels (COHb).

TABLE 7*
Gases Identified with Combustion of Materials

Toxicants	Source Materials
Aldehydes (Acrolein, Acetaldehyde, Furfural, etc.)	Hydrocarbons (Polyethylene, Polypropylene, Polystyrene) Cellulosics (Wood, Paper, Cardboard) Phenol-formaldehyde Polymers Urea-formaldehyde Polymers Urethane Polymers Polyesters
Ammonia	Nitrogen-containing Materials (Nylon, Polyurethanes, Melamine, etc.)
Benzene	Hydrocarbons, Olefinic Polymers (Polyethylene, Polypropylene, Polystyrene, Polyvinyl Chloride)
Carbon Dioxide, Carbon Monoxide	All Carbon-containing Materials
Halogen Acids (Hydrobromic Acid, Hydrochloric Acid, Hydrofluoric Acid)	Halogenated Plastics Brominated Polyesters, Polyvinyl Chloride, Vinylidene Chloride, Chlorinated Polyethylene, Polytetrafluoroethylene Halon Fire Retardants Halogenated-fire Retarded Natural and Synthetic Materials
Hydrogen Cyanide	Nitrogen-containing Materials (Wool, Silk, Leather, Polyurethanes, Urea-formaldehyde, Nylon, etc.)
Isocyanates	Urethane Polymers
Nitrogen Oxides	Nitrogen-containing Materials (Polyurethanes, Nylon, Wood, Cellulose, etc.)
Hydrogen Sulfide Sulfur Dioxide	Sulfur-containing Materials Sulfur-crosslinked Natural and Synthetic Rubber, Polysulfides
Heavy Metals (Lead, Tin, Antimony, etc.)	Natural and Synthetic Materials Containing Metallic Additives such as Stabilizers, Fire Retardants, etc.

*Source: *Smoke Control in Fire Safety Design* by E. G. Butcher and A. C. Parnell (Modified by the Committee).

This table is cited to illustrate that all organic materials used in buildings can emit toxic smoke during combustion.

Unfortunately, the cause of deaths cited as being due to carbon monoxide poisoning is often based upon the judgment of the individual conducting the autopsy, without knowledge of the carboxyhemoglobin levels in the victim's blood. Although it is but one of the many potentially toxic constituents present in fire smoke, carbon monoxide is nearly always present in greater concentrations than other toxic gases, and experts conclude that it causes most fire fatalities.

Numerous studies have been conducted using modern analytical methodologies to determine the specific compounds (their toxicity and concentration), emitted during the decomposition of a broad spectrum of common building materials and furnishings. One study identified more than fifty decomposition products which were produced during the pyrolysis or combustion of wood. Another study identified more than sixty compounds produced during the pyrolysis of vinyl chloride polymers.

Combustion atmospheres are extremely complex and dynamic, and contain many varied toxicants which may produce additive, synergistic, or antagonistic responses in test animals or humans. Inasmuch as it is not possible to identify and monitor in the animal's system the uptake of the specific toxicant, a true "dose—response relationship" cannot be determined.

Table 7 lists common classes of toxicants which may be produced during the thermal decomposition (pyrolysis and/or combustion) of commonly used materials of construction or furnishings. The toxicants listed in Table 7, are commonly encountered during building fires, but this list is incomplete and is presented only to show the complexity of smoke.

Any assessment of smoke or combustion products toxicity must consider the total concentration of products present in smoke (gases, aerosols, and other particulates) released into a given space over a stated period of time. When this value is multiplied by time to a given response, and divided by the weight of the animal or human body an approximation of the total "concentrated response" can be attained.

4.3 Test Methods

Several laboratory test methods have been developed for determining the weight of test material which produces sufficient combustion products to cause lethality in 50% of test animals (LC50) during a stated exposure period. The test goal is to determine that LC50 value by exposing materials to a simulated fire environment. No test exists today that is agreed upon as adequately simulating fire environments. Test methods are needed for determining the relative toxicity of building materials, components, and furnishings. Measurements can be made under controlled test conditions of either flaming combustion or non-flaming pyrolysis. There

are numerous reports available which offer technical evaluations of existing toxicity test methods. At least 14 such methods were reviewed in the course of developing this report. The NIBS Task Force determined that specific information on the merits of the test methods studied was beyond the scope of this report. It is, however, important to recognize that a broad range of tests has been developed, and new test methods are being designed. As of this writing, there is no consensus on any single test method that is appropriate for broad application.

The objective of each of the tests studied is to measure the short-term toxicity effects on animals of smoke in limited dosages. Other parameters that can be quantified with bioassay experiments include mortality, time to first death, number of unconscious animals expressed as a percentage of animals exposed, and time to first collapse. Some investigators attempt to relate the test data to the likely reaction of humans to inhalation of similar gases. Tests for locomotor ability can be carried out by requiring the experimental animal to run inside a powered revolving cage or by allowing the animal to run inside a freely unpowered cage. Times-to-failure of the animal to run successfully are recorded for analysis.

With regard to the laboratory tests in existence today, it must be emphasized that no laboratory apparatus can reproduce the changing conditions of fire and the concentration dynamics of toxic smoke and gases. This is an important limitation of all fire test methods. For example, ASTM tests E119 and E84 do not try to duplicate the wide variety of conditions that occur in actual fires. These tests distinguish between various materials or assemblies based on their performance when exposed to standardized fire conditions in a laboratory. Despite their lack of precision, these tests offer useful distinctions between materials and are therefore widely relied upon by building designers, product designers and regulators. Those who wish to address questions of toxicity testing may similarly have to decide whether various test methods, although imperfect, are capable of providing useful distinctions between various materials.

4.4 Use of Test Data

Measurement of the smoke toxicity of material specimens would be desirable and potentially useful for designers and builders if it could be related to real fire hazard. However, tests conducted to date indicate very little about the total risk from burning materials in a real fire situation. Small scale test methods inherently ignore several important aspects of the smoke problem. Studies are being made at several laboratories to correlate the results of material tests, with the

conclusions drawn from larger-scale multicomponent, systems tests. Factory Mutual intends to conduct full scale building burns in 1983. Information from these tests, when available, together with information on ignitability, flammability, flame spread, smoke obscuration, and heat generation could form the basis for a reliable fire risk model and be useful in the development of a material toxicity hazard index.

It is important to note that several additional questions will need to be addressed before consensus can be achieved on the most desirable test methodology or on its relevance to regulating building materials. Such questions include:

1. What is the validity of the test?
2. What degree of precision is adequate for test result acceptance?
3. Does application of a single test method require precise acceptance of laboratory results between laboratories?
4. What is the impact upon:
 - 1) product manufacturers?
 - 2) design professionals?
 - 3) code officials?
 - 4) the laboratory conducting the tests?
 - 5) owners?

5.0 What new information or new tools might be needed to help in assessing risk in building fires?

The National Institute of Building Sciences' Task Force on Toxicity of Combustion Products in Building Fires has accumulated numerous recommendations from researchers, industry groups, product manufacturers, code groups, government agencies, academic institutions and consumers concerning the practicality and desirability of including toxicity test provisions in building codes. Other recommendations have been offered with respect to informational needs for specific groups, particularly building occupants and design professionals. Broadly, divergent views are held on the utility of toxicity test methods and the information they yield. Standards-writing organizations are continuing to develop test methods for measuring the toxicity of products of combustion. In light of this, there remains a two-fold problem to be addressed:

1. Development of a *reliable test* that simulates the fire environment and can give an evaluation of the relative toxicity of the combustion products of a material under an acceptable fire environment.
2. Development of or agreement upon a method which uses the toxicity of combustion products or certain materials in a toxic hazard index.

5.1 What New Information Is Needed?

The Task Force recognizes five important points in presenting this report: (1) that toxicant concentrations at a particular location and time are established by fire dynamics, making each potential building fire situation totally unique; (2) that all building fires produce potentially lethal concentrations of toxicants; (3) that a reduction of the toxic threat may be possible through effective control of fire, recognizing that the same problems in the breakdown of fire protection measures currently experienced in large life loss fires can influence fire and smoke control; (4) that, as with other controversial and complex health and safety issues, it may be difficult to achieve a consensus on the proper course of action for regulatory entities to pursue; and, (5) that existing toxicity test methods have not been validated at this writing. More development and testing is needed before such methods can provide meaningful and comparable data on contemporary building materials.

Recommendations

6.0 Summary of needs, and recommendations

The Task Force has determined that a great deal of research and development should occur in the field of toxicity testing relative to building codes and standards. In arriving at the following recommendations, the Task Force considered suggestions from a variety of concerned groups as well as the authoritative documents referenced in this report. The Task Force believes that a consensus exists within the building community on the areas of need listed below; and makes the following recommendations:

6.1 Building Codes and Fire Protection Standards

The building codes and standards writing organizations should review their provision to determine if their system of smoke control provides a consistent and adequate set of requirements. For example, some of the following issues have been raised:

- reliability of the systems under the fire conditions;
- considerations of control of furnishings with respect to material fire performance; and
- the interaction with other building fire safety systems.

6.2 Hazard Assessment Methods

There is a need for the development of fire risk assessment methods that integrate smoke toxicity, ignition, flame spread, and the amount and rate of heat and smoke release. Such methods may further be influenced by factors such as containment, detection, suppression, building type, occupancy classification, and smoke control.

6.3 Smoke Control

6.3.1 There is a need for research which will contribute to improvements in the design of smoke control systems. Some of the areas which need further research are the magnitude of external and internal air leakage within existing building technology, methods of pressurizing shafts, and how to design smoke venting and exhaust systems.

6.3.2 There is a need for a standard establishing guidelines and criteria for smoke control systems.

6.3.3 There is a need for effective and continuing training in smoke control measures. Proper design of smoke control systems requires the close cooperation of building owners, designers and the fire services. Effective functioning of smoke control systems in a fire emergency requires detailed knowledge by and close cooperation between the building engineer and the fire ground commander.

6.4 Product Information

6.4.1 Product and material manufacturers' associations should adopt voluntary practices to provide fire property data derived from the use of standard toxicity, heat release, ignitability, and other flammability test methods available.

6.4.2 In the absence of standard toxicity test protocols adequately correlated to actual fire conditions, product and material manufacturers are encouraged to collect and disseminate responsible information on health effects of their products in actual fire conditions.

6.4.3 NIBS should provide a forum for industry associations to develop and discuss the use of voluntary guidelines for manufacturers of building materials and contents that take into account the fire properties of materials including smoke hazards, which will assist them in establishing and meeting their related product responsibilities.

6.5 Education

6.5.1 There is a need for an expanded nationwide education program aimed at occupants to provide them with current fire safety and evacuation information. It should include facts concerning fire hazards, smoke toxicity, the critical issue of time, safe evacuation practices; and practical guidance for the selection and use of fire safety equipment.

6.5.2 It is recommended that associations of building designers, owners, and operators develop and disseminate information on fire safety design and practices including current information on smoke hazards and communications and education materials for building components.

6.6 Research

6.6.1 NBS should be encouraged to continue the development of laboratory smoke toxicity testing that is adequately correlated to full scale fires.

6.6.2 There is need for research on the effects of smoke particulates and gases in order to understand the nature and extent of toxic threats to humans in real fire situations.

6.6.3 There is a need to collect and make available data on toxic smoke products present during actual fire fighting and clean-up conditions, and on the physiological effects of fire exposure on immediate and long-term human fire casualties.

6.6.4 There is a need for research into realistic and cost effective methods to retrofit existing buildings with smoke control systems.

Appendix A

List of Participating Organizations

American Fire Sprinkler Association, Inc.
 American Iron & Steel Institute
 American Institute of Architects
 American Medical Association
 American Society of Heating, Refrigerating and Air-
 Conditioning Engineers, Inc.
 American Society for Testing and Materials
 American Telephone & Telegraph Company
 American Wall & Ceiling Industries
 Armstrong World Industries
 Arthur D. Little, Inc.
 Benjamin/Clarke Associates, Inc.
 BFGoodrich Company, Chemical Group
 British Standards Institution
 Building Officials & Code Administrators International, Inc.
 Building Owners & Managers Association
 Carlon Company
 Carpet and Rug Institute
 Center for Environmental and Materials Research
 CertainTeed Corp.
 Citizens' Committee for Fire Protection
 City of Beverly Hills, Department of Building Safety
 Congressional Research Service
 Council of American Building Officials
 Dow Chemical Company
 DuPont Company
 Factory Mutual Research Corporation
 The Foundation for Fire Safety
 General Electric Company
 Goldberg Research & Development Associates
 Corporation
 Gypsum Association
 Harvard University
 William E. Fitch, P.E., Consulting Services
 H. B. Fuller Company
 J. E. Johnson, Fire Protection Consultant
 Johnson Controls, Inc.
 Daniel L. Kent, Consultant
 Koppers Company, Inc.
 Man-Made Fiber Producers Association, Inc.
 Monsanto Industrial Chemicals Company
 National Academy of Sciences
 National Bureau of Standards
 National Electrical Contractors Association
 National Electrical Manufacturers' Association
 National Fire Academy
 National Fire Protection Association
 National Forest Products Association
 Owens/Corning Fiberglas Corp.
 Plumbing Manufacturers Institute
 PPG Industries, Inc.
 Republic Steel Corporation
 Rohm & Haas Company
 Shell Chemical Company
 Smoke Control Association
 Smoke/Fire Risk Management, Inc.
 Society of American Wood Preservers
 Society of Automotive Engineers, Inc.
 Society of the Plastics Industry
 Southern Building Code Congress International, Inc.
 Southwest Research Institute
 Swankin & Turner, Attorneys at Law, National Consumers
 League
 Tishman Research Corp.
 Transcolor Inc.
 Underwriters Laboratories Inc.
 University of Maryland
 University of Pittsburgh, Graduate School of Public Health
 University of Saskatchewan
 U.S. Army, Plastics Technical Evaluation Center
 U.S. Consumer Product Safety Commission
 U.S. Department of Agriculture, Forest Service
 U.S. Department of Commerce
 U.S. Department of Transportation
 U.S. Fire Administration/FEMA
 U.S. Veterans Administration, Office of Construction
 Weyerhaeuser Company

Appendix B

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Minority Opinions

Opinion Filed By: The Foundation for Fire Safety

I. The final draft does not fulfill the basic charges of the Task Force. The assignment to the NIBS Task Force is clearly stated in the last paragraph in the Introduction.

"The NIBS Task Force was specifically charged with conducting a study to evaluate the need for a standardized toxicity test method in building codes, and with establishing the parameters of its use in codes if such a need exists."

The final document does not fulfill this charge since the evaluation of a need was never addressed.

II. The document appears to start with the assumption that smoke toxicity should not or cannot be used in building fire codes to reduce human fire loss. The document is then devoted to showing why this is the case. The second sentence in the introduction is the clue to the preconceived position of the Task Force. This sentence states that:

"The premise was accepted that every fire situation involves a different set of toxicology circumstances with regard to fire related deaths."

This statement simply states the impossibility of improving life safety by having a standardized toxicity test method in the building codes since a standardized test method will approximate at most only one fire. This argument appears again in section 4.3. However, all fire test methods have the same difficulty. As a matter of fact, the document recognizes that this is a limitation of *all* fire test methods. In spite of this limitation, the document as prepared by the task force, sup-

ports the use of standardized flammability test methods but denies the usefulness of a standardized toxicity test method. This position is inconsistent.

III. The document does not really address the smoke toxicity issue until section 3.1. It fails to even acknowledge that test methods for measuring smoke toxicity exist until paragraph 6.4.1, where it suggests that manufacturers adopt voluntary practices for testing products according to a standard toxicity test method.

IV. The document lacks scientific integrity since statements supporting a given position are used without reference. For example, in the Introduction the Southwest Research Institute, the NFPA and the Center for Environmental and Materials Research are listed as doing studies related to autopsy results. I do not know what studies are referred to since I know that none of these organizations have carried out autopsy studies or studies related to autopsies. Specific literature references must be cited to support a given fact/opinion if the document is to have scientific credibility.

Sincerely,
Merritt M. Birky, Ph.D.
Director of Research

Opinion Filed By: Citizens Committee for Fire Protection

The undersigned dissent from the report of the Task Force. This report does not present an adequate or balanced picture of the toxicity problem or of current research in the area.

This failing was perhaps inevitable, given the unfortunate history of the Task Force itself. On August 2, the Task Force sponsored a symposium on toxicity in Washington, D.C. The attendees, many of whom were not Task Force members, represented a broad range of interests in the on-going controversy over toxicity, and many diverse opinions were aired.

Despite the range of views presented, NIBS sent a telegram the next day to the Consumer Affairs Committee of the California State Assembly, reporting that the August 2 meeting had formed a consensus against toxicity regulation. The telegram said that the participants in the meeting "generally agreed" that existing test methods for determining the potential threat of toxic gases lack scientific accuracy and a direct relationship to buildings; and that the "strong consensus of opinion" among participants is that it is premature to incorporate toxicity test methods in building regulations.

This telegram was inexcusable, in that the August 2 meeting did not come to any consensus or general agreement on these issues. Indeed, the lack of consensus was the most apparent feature of that meeting.

The procedural policies of the Task Force have improved considerably since August; regrettably, though, the substance of the report has never recovered from these unfortunate beginnings.

Our detailed criticisms of this report could run into many pages. Rather than criticize the report page by page, though, we simply note here two overall shortcomings that pervade the entire document:

1. The report does not explore adequately the fire problem in the United States and, in fact, goes out of its way to minimize the problem. It presents a variety of statistics relating to fire death and injury. Some of these statistics are questionable at best; others seem to be in conflict with one another, but there is no explanation of the discrepancies.

Based on our understanding of the methods employed by the various sources cited, we accept the statistics of the U.S. Fire Administration: that is, about 7,600 fire deaths per year, of which 6,000 occur in residential fires.

We object strenuously to the statistic purporting to show that there are fewer deaths per fire in the U.S. than in other nations. This figure obviously depends on the number of reported fire incidents. In countries where the populace has

a tendency to call the fire service for numerous minor incidents, the number of reported "fires" will be very large, and the number of deaths per fire consequently very low.

We are also distressed to note that various charts and statistics tending to minimize the fire problem have appeared in the report since the last meeting of the Task Force, with no discussion by the group as to their significance or validity. These include Table 1 (Civilian Deaths per Million People) and Table 3 (Major Loss of Life in Twentieth Century Building Fires), both of which are open to serious question.

2. The major portion of the Task Force report is based upon two assertions which may be correct, but which are so broad that they obscure the real issues. The first of these assertions is that all smoke is toxic to one degree or another. Relying on this assertion, the report fails to explore adequately two major aspects of the toxicity problem now before the public:

- a. Whether the combustion products given off by some materials are significantly more toxic than those given off by others; and
- b. Whether some materials give off their toxic products at such a rapid rate as to reduce significantly the chances that occupants will escape from a fire.

These are precisely the issues that have been raised by the fires in the Beverly Hills Supper Club and the Younkers Department Store, among others. (See, e.g., Wallace, "Dangers of Polyvinyl Chloride Wire Insulation Decomposition," *Journal of Combustion Toxicology*, Vol. 8, page 205 (November 1981) and Vol. 9, page 105 (May 1982).)

The second overly broad assertion is that every fire presents a totally unique set of toxicological circumstances. As noted by the Foundation for Fire Safety, the Task Force report seems to imply from this that it would be impossible to regulate toxicity through any standardized test, since any such test could represent, at most, only one real-world fire.

The issue obscured by this assertion is whether currently-available toxicity tests, although not representative of all real-world fires, are nevertheless good enough to provide builders, manufacturers and regulators with useful distinctions between materials. The report raises this issue briefly, but does not explore it.

Rather, the report seems to proceed to the conclusion that little can be done to regulate combustion toxicity until we have a universally satisfying test.

We do not accept this conclusion. Regulators and product manufacturers have long used standardized tests to measure flamespread, fire endurance, and other fire-related properties. These tests, like the various tests proposed for toxicity, subject the specimen to a standard set of fire conditions and rate its performance accordingly. The standard set of fire conditions is by no means representative of all real-world fires; yet it is widely acknowledged that the tests are a good enough representation of the real world to provide regulators and product designers with useful information.

The time has come to take the same step in the field of toxicity testing. At the very least, we should consider whether the existing tests, although not perfect, would enable us to identify and eliminate the worst actors among currently used synthetic products. Further refinements will come in due time.

THE CITIZENS COMMITTEE FOR FIRE PROTECTION

Arthur C. Delibert
President
SWANKIN & TURNER
David Swankin

**Opinion Filed By:
Harry Shaw & Associates Inc.**

The President and the Congress have authorized the National Institute of Building Sciences (NIBS) to advise Federal, State and local governments on the use and inclusion of technology in the building codes. With this authority and current technology, NIBS has the opportunity to help eliminate this Nation's fire problem as we know it today. In addition, NIBS' effort directed to the fire problem may prevent the waste of billions of dollars which would undoubtedly have to be spent with the implementation and enforcement of new toxicity regulations into State and local building codes. And finally, NIBS, by promotion of the fact that fire toxicity problems are a by-product of combustion, could contribute logic to the thinking of those individuals in the fire community who do not really understand the relationship between fire and toxicity. It must be established and understood that, when the combustion is controlled there will not be a toxicity problem.

It is the intent of this report to provide information which would convince and encourage NIBS to make a major contribution to mankind by playing a lead role in solving the fire problem. Additionally, it is the intent of this report to introduce into the record what appears to be the available solution to the fire problem: a combined smoke detection and fast response sprinkler system which have been made possible with recent technology developments. This available and cost promising solution does not require additional toxicity knowledge.

During the past decade not only have enormous strides been taken in the development and use of technology to solve the fire problem but also significant strides have been taken to obtain an understanding of the problem. This new understanding came from information and data provided by the U.S. Fire Administration's National Fire Incident Reporting System and from improved reporting and analyses from the National Fire Protection Association (NFPA) and from the National Bureau of Standards/Center for Fire Research. Today, we know the fire problem.

For the past 150 years, without adequate knowledge of the fire problem, we have been introducing, through codes, standards, and State and local ordinances, fire protection safeguards at a probable cost in excess of a hundred billion dollars. In spite of these costly safeguards the United States still has the worst fire problem in the industrialized world. Unfortunately, many of the fire safeguards are not only costly

but are also ineffective. With the knowledge of the technology and the problem now available to the fire community there is no longer an excuse to be wasteful and ineffective.

For the most part, this paper will not reveal anything new to the members of the fire community; it will, however, get into the record the established and well known solution to the fire problem and demonstrate that while additional knowledge about toxicity may be desirable, such knowledge is not required to solve the fire problem.

Dr. Ann Phillips, in her presentation to the NIBS Toxicity Task Force on August 2, 1982, highlighted the fire problem with her comment "in a lifetime approximately 1/2 million people will die from fire."

To expand on her statement of the problem, we could say "approximately 80% of the deaths will be in residential fires and the vast majority of all deaths will be from inhaling the products of combustion rather than direct contact with the fire." Other parts of the fire problem include injuries, property losses, treatment of shock for fire victims, and overall costs.

In a lifetime approximately 14 million people will be injured from fire and about 70% will be in residential fires.

In a lifetime approximately 500 billion dollars of property loss will result. About 45% will be residential.

In a lifetime over eight million people will suffer the shock of a serious fire and about 25% of these will require extensive and expensive treatment; some may never recover. The cost for this indirect fire loss is over 21 billion dollars.

And finally, in a lifetime, the total cost of fires for public fire protection, insurance, property damage, business interruption, etc., is over two trillion dollars.

That is the problem; now, how can current technology be applied to reduce the losses and costs to a minimal level?

First, let us look at smoke detectors. In 1976 less than 5% of the homes in the United States had a smoke detector. Today, as a result of total involvement of the fire community, over 67% of the homes have one or more smoke detectors. States and communities have credited smoke detectors not only with a reduction of fire deaths and injuries but also a reduction of property losses.

In one study by the International Association of Fire Chiefs Foundation, smoke detectors were responsible for first notification in 40% of the incidents investigated. During sleeping hours smoke detectors were responsible for first notification in 90% of the incidents. In another study in a Navy Marine Corps housing complex of 30,000 units and 120,000 occupants, the average life loss from fire over a 10 year period through 1977 was 5.8. Since smoke detectors were installed in 1977 there have been *no lives lost* from fire. Other studies in California, Florida, Prince Georges County, MD, and Dallas, TX, all indicate a favorable impact on reducing fire loss.

Smoke detectors do, in fact, provide early warning and are a most valuable contribution to residential fire protection.

The program to explore the possibility of a low cost sprinkler system for reducing residential fire losses was started in 1976 by the U.S. Fire Administration, with many partners of the fire community, including the National Fire Protection Association, the National Bureau of Standards/Center for Fire Research, Factory Mutual Research Corporation, Underwriter's Laboratories, Grinnell Fire Protection Systems, Co., Inc., Shell Chemical Company, Schirmer Engineering Corporation, Rolf Jensen and Associates, Allstate Insurance Company, the Marriott Corporation, and fire departments in Los Angeles, California, Charlotte, North Carolina, Cobb County, Georgia, and San Clemente, California.

The fast response, low cost residential sprinkler system was tested and demonstrated in numerous programs from 1977 through 1982. The programs included about 70 live burn tests in Los Angeles, 9 of which were for the insurance industry; 16 mobile homes tests in Charlotte, North Carolina, 3 mobile home tests in Springdale, Arkansas; and a series of modified NFPA 13D tests in Cobb County, Georgia. The results of these tests indicated that the fast response sprinkler system not only reduced fire property losses by 85% but also provided a life safety environment in the room of origin. When one considers that 50% of the fire death victims are too young, too old, too intoxicated, or handicapped, survivability in the room of origin is of prime importance. The results of the insurance sprinkler fire tests conducted in 1979 by an Ad-hoc Committee representing the insurance industry showed a 4 1/2 to 1 reduction of fire claim expenses. Based upon this dramatic saving the committee recommended a significant premium reduction be considered by the industry. Today, as a result of this recommendation, 38 States have adopted a 15% premium credit against the total homeowners policy.

The next series of tests were conducted in Scottsdale, Arizona, San Francisco, California, and Cobb County, Georgia. The results of these tests, since occupants remained in the room of fire origin from ignition through extinguishment, demonstrated that the room of origin was, in fact, a survivable environment since all of the occupants, calmly and slowly, left the fire rooms after the fire had been extinguished. None of the occupants showed any ill effects from their experience. In Scottsdale, Arizona, Lou Witzeman, Chairman of the Board of the Rural Metro Fire Department, became the first live guinea pig to occupy the room of origin. As he left the house, after the fire was extinguished, his comment was "a piece of cake." In the San Francisco test the occupants were Mayor Dianne Feinstein and Fire Chief Andy Casper. The Mayor's first comment upon exiting the building

was "it's a life saver." In Cobb County, Georgia, Chief Dave Hilton and four members of the County Council demonstrated the effectiveness of the fast response sprinkler system with a group meeting during a live burn test. The fast response polybutylene sprinkler was remarkably effective.

The next phase of the testing and demonstration program was made possible by replacing the standard link in Grinnell's commercial sprinklers with the new fast response residential link. This series of tests explored the use of the fast response sprinkler concept in a light hazard hotel fire situation. The Marriott Corporation initiated a series of 10 hotel fires which were conducted in Fort Lauderdale, Florida, under the management of the NFPA. The sprinkler system was comprised of fast response sprinkler heads and polybutylene pipe and fittings. Most, if not all, of the 250 fire community witnesses were satisfied that the fast response sprinkler concept provided a life safety environment in the room of origin and greatly reduced potential fire damage. The polybutylene piping system performed without a flaw and established the possibility of low cost retrofitting for the 55,000 unsprinklered hotels and motels in the United States, as well as other occupied buildings.

As a result of the fire tests utilizing the fast response sprinkler and polybutylene pipe conducted in November 1981 and July 1982 in Cobb County, Georgia, fire and other municipal officials are convinced that the installation of residential fire sprinkler systems in multi-family housing with three or more units of three stories or less (commonly known as "cluster" housing) may accomplish several timely objectives. The first, and most important of these, of course, is to reduce deaths from residential fires. The second objective is to reduce the amount of property damage resulting from such fires. And finally, since residential fire sprinkler systems provide a substantial degree of on site fire protection, municipal resources required to fight fire in sprinkler protected dwellings may be stabilized. This may allow budget conscious local fire officials to hold the line or reduce capital expenditures that will be necessary to meet expanded population growth if residential fire sprinklers were not installed.

The total number of units with the new fast response sprinkler protection is now over 1,700. Of major interest is the fact that these structures are now being constructed with full sprinkler fire protection at a lower cost than without the fire sprinkler system. The lower cost is attributed to a series of trade-offs which, in the judgement of Cobb County's Chief Dave Hilton, do not in any significant way compromise fire protection.

The results of all the tests indicated that the fast response sprinkler system controlled carbon monoxide levels within tolerable limits. The test results in Springdale, Arkansas and Fort Lauderdale, Florida, show that the fast response sprinkler system maintained hydrogen chloride and hydrogen cyanide toxicity levels within survivable limits. The tests in Cobb County, Scottsdale, Springdale, and Fort Lauderdale demonstrated that the polybutylene pipe performed as well as any other material. In summary, the results of the residential test programs have demonstrated that the combined polybutylene pipe and fast response sprinkler system will enhance life safety with control of temperature and toxicity and in addition, it will reduce fire losses by about 85%.

With regard to commercial buildings, sprinkler systems have, for many years, played a vital role toward reducing fire losses of life, injuries, and property. The National Fire Protection Association reports that, with the exception of a few cases where there was either an explosion or the individual was the object of the fire, *no one had died from fire in a fully sprinklered building*. In addition, the Factory Mutual Research Corporation has given sprinkler systems the credit for reducing fire insurance losses from 30¢ per \$100 of insured value to 2-3¢ per \$100 of insured value.

If we accept the findings of the smoke detector reports and the findings of the live fire sprinkler programs conducted over the past five years we must conclude that the fast response low cost sprinkler system and smoke detectors are not only the answer to the fire problem but also an answer to the toxicity problems.

The opportunity now exists for NIBS to play a major role with Federal, State and local governments to eliminate the fire problem as it exists today. With the support of NIBS and the fire community we may see the day that most fully sprinklered buildings, using only reasonable and acceptable trade-offs, could be constructed at lower costs than unsprinklered buildings. NIBS should be challenged to use its authority delegated by the President and Congress to play an essential role in solving the fire problem in the United States. The solution to the fire toxicity problem will follow.

Harry Shaw

**Opinion filed by:
American Iron and Steel Institute**

This letter is to explain my objections to the publication and distribution of the NIBS State-of-the-Art Report on Toxicity in Building Fires. In the introduction to the Report it is stated that:

"The NIBS Task Force was specifically charged with conducting a study to evaluate the need for a standardized toxicity test method in building codes, and with establishing the parameters of its use in codes if such a need exists."

In order to answer such a controversial question, it is imperative that the Task Force or Committee membership be carefully balanced in accordance with NIBS procedures. I suggest that review of the interests of the voting members raises a serious question on this fundamental point of committee balance.

All fires in buildings involving combustible or flammable material produce combustion products which are toxic. The way in which the building or other codes regulate the use of combustible material will influence material involvement in a fire. Since sound fire protection practice dictates a redundancy in fire protection methods, one of the most important items is—if all the fire protection measures fail—what is the relative toxicity of different materials when burned. The test used to measure toxicity does not necessarily have to simulate all the conditions which could possibly exist in a fire. Other accepted standard fire tests use arbitrary test conditions which represent but one fire condition.

The second consideration is that a fire hazard assessment method should be used in order to determine the hazard to individuals exposed in a fire situation. I question if NIBS is the proper group to do this job. In my opinion NFPA is better qualified because its staff has the background and the membership includes broad fire protection interests.

Finally, the report in its present form does not enhance the image of NIBS in that it is poorly written and does nothing more than present a confused rehash of the toxicity question. The first draft was bad and the current version is not much better.

There are two other toxicity reports which have recently been released. One is the Southwest Research Institute Report done for SPI and the other is a report done by the National Fire Protection Association. The latter is not mentioned in the report.

By publishing the Toxicity Report, NIBS has not adequately addressed the technical issues which continue to confuse the public.

Richard G. Gewain



National Institute of
BUILDING SCIENCES

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August 8, 1983

The Honorable Orrin G. Hatch
Chairman, Committee on Labor and
Human Resources
United States Senate
Washington, D.C. 20510

Dear Senator Hatch:

Thank you for your letter of July 26, 1983, transmitting further questions pertaining to the NIBS' work in the area of fire safety. Our responses to your questions are presented below:

1. "Can you briefly summarize some of your recommendations in your report entitled Toxicity Effects Resulting from Fires in Buildings?"

Perhaps the most important recommendations contained in our report (page 12) are those that address the current need for public education and technical guidelines. These two areas are critical to progress toward protecting the public from smoke and fire. Additionally, emphasis should be placed on developing rational risk analysis techniques with respect to building materials and their potential involvement in a building fire. This point is very complex and great care should be taken to assure that the full range of fire safety/protection measures have been considered in the analytical model, for whatever fire scenario is anticipated.

2. "Can you explain what is being done to protect the public from toxic combustion products in buildings?"

As stated in our testimony, buildings are designed and constructed to include many fire safety devices under the assumption that a fire may occur at some point in time. It would not be rational to assume otherwise. Building codes have evolved over time and incorporated numerous technologies for fire protection and smoke control such as: fire alarm systems, fire doors, fire escapes, fire exit hardware, fire extinguishers, fire separators, and special construction in exit corridors. Architects, engineers and building code authorities all assume a significant amount of responsibility as they design, specify and review building components intended to protect the public from fire and smoke. By and large, design professionals and code officials are doing a great deal to protect the public from hazards in buildings.

3. "Has NIBS addressed the issue of relative toxicity among combustible materials?"

Yes and we intend to do more in this area. Preliminary opinions are that indexing or ranking materials in accordance with the intensity of toxicant emitted during pyrolysis is unsatisfactory. The reasons are quite simple. Each fire scenario is unique with nearly infinite possibilities for heat generation, time/temperature variations, source of ignition, and materials involved. What may be a lethal situation in one instance may be a harmless situation in another by virtue of a slight variation in temperature or by the existence of chemicals that neutralize one another when combining at certain rates and at certain temperatures. The synergistic effects of combustion products across the enormous range of possible fire situations is an area of intensive study and debate at the present time.

4. "Can you explain how NIBS's findings and recommendations become part of local building codes?"

The Institute provides a forum for the building community to air its problems and arrive at rational solutions. When those solutions impact building codes, the three model code groups seriously consider NIBS' sponsored findings. If revisions to the model codes result, state and local building officials are advised of the change and they may adopt or amend a code provision to be consistent with the applicable model code. Additionally, building standards may be adopted by reference in state and local building codes. In addition, the NIBS membership (Consultative Council) includes many local building officials who gain immediate access to NIBS' findings through the Building Sciences newsletter and by way of participation in NIBS project committee work.

5. "How can local building codes be used to minimize toxicity in fires?"

In short, they can do nothing to minimize toxicity. However, provisions to require smoke detection, better routes of egress, and more rigorous building inspection are effective.

- 6) "Can you explain the difficulties of strict enforcement of codes?" Does this responsibility rest mainly with local agencies?"

The design and construction of buildings involves an intricate set of checks and balances between the design professional (usually an architect) and the code official. When plans are signed and sealed by the architect he is attesting to the fact that he has designed the building "in accordance with all applicable codes and standards." There is a significant degree of professional liability associated with this assertion. Code officials then check to see that, indeed, this claim is correct and that no oversights exist in the plans and specifications which would adversely impact the health and safety of building occupants. There is also a degree of liability associated with this function. Strict code enforcement is often a matter of saying yes or no to proposed usages of materials, dimensional configurations, or occupancies. Code provisions guide the code officials in such determinations. The practical problems of man-power, level of technical expertise, and funds with which to properly operate a review and inspection department are real limitations on which may hinge life and death circumstances involving the public.

7. "How do you suggest we go about informing the public of the dangers of fires in order to reduce the number of deaths and injury from fires?"

The National Fire Protection Association has had a public awareness program ongoing for many years. The "Learn Not to Burn" campaign has been highly successful and should be supported. Other mass-media programs, even some with federal sponsorship, should be considered in order to provide simple and direct instruction to the public on proper behavior during a fire emergency.

8. "What are some of your recommendations for voluntary guidelines to reduce the risk and damage of fire and smoke hazards in buildings?"

As presented in our report, NIBS should provide a forum for industry groups and others to define the proper format and content for technical guidelines to serve three primary user groups, product manufacturers, design professionals, and code officials. The guidelines should focus on technical information not widely available, currently, for reference and use. Data on the expected by-products of combustion when building materials burn would be useful, if presented properly, to design professionals and code officials. Methods of generating data on potential toxicants vary widely. However, the methods need not be so well defined and sophisticated as to encumber a product manufacturer's ability to freely market its product and maintain control over its enterprise. Generic data on chemical compounds and combustion products can be incorporated into product literature and technical reference sources as a further point to consider when design professionals make product selections. A comparison based solely on the potential by-products of combustion should never occur. However, some integrated approach to evaluating ignition, flame spread, rate of heat release, smoke generation, toxicity, etc. may eventually be developed. NIBS has said that such a technique is needed and the Institute, through its open consensus process, will actively pursue the identification of appropriate criteria on which to base this technique.

NIBS in cooperation with NFPA, ASTM, product manufacturers, design professionals, code groups, fire officials, scientists, and consumers will attempt to develop the guidelines recommended in our report. Discussions are already underway with the Environmental Protection Agency (EPA) to identify an appropriate federal role in this activity. The Senate Appropriations Committee for HUD and Independent Agencies has urged EPA to provide grant monies to NIBS in an effort to expedite the guideline effort. Other agencies of the Federal government, including those within the jurisdiction of this Committee, could become active participants in this project.

On behalf of the National Institute of Building Sciences, I am pleased to present these supplemental views in response to your questions. If further details are needed concerning the proposed guidelines, please contact Mr. Steven L. Diegel, AIA, of the NIBS staff.

Respectfully submitted,

Wayne P. Ellis

Wayne P. Ellis
Senior Standards Consultant
H. B. Fuller Company

Senator QUAYLE. Dr. Lyons, do you agree with what Mr. Ellis said about where we are, that we really need to continue our research and the cooperative effort that was brought out in this last panel?

Mr. LYONS. Well, there is certainly a great deal of research yet to be done. The Bureau of Standards, of course, is dedicated to doing as much of that research as we are able. Yes; I think it is a good thing to do as much as we can and to do it in a cooperative mode.

At the Bureau over the last 10 years we have had a number of what we call research associates. They are really guest workers drawn from industry or sponsored by trade associations to work on various programs where they may bring some expertise. For example, if the sponsoring organization is a company that makes materials, a senior scientist who understands the properties of those materials is sent to us. We try to balance the mix of these visiting scientists so that no organization has an unfair advantage in our laboratories. I think cooperative research with the private sector is a very powerful mechanism, and the Bureau represents a sort of neutral ground where people can come together and do such work. I am very much in favor of that.

Senator QUAYLE. OK.

Senator Randolph.

Senator RANDOLPH. Dr. Lyons, the National Bureau of Standards, of course, is an organization in which we have tremendous confidence. Do you feel, or is there a study which supports a proposal that sprinkler systems should be required in single-family residential homes?

Mr. LYONS. Senator, I think sprinklers are one of the most effective tools we have for combating open or flaming fires, and I think the recent developments in lower-cost, rapid-acting sprinklers are very encouraging. We have a way to go, and I think that what will happen ultimately in the matter of sprinklers in the home is that the population, represented primarily by the building regulatory officials, will have to make the trade-off between the added cost for such systems in a home and the added safety benefits that are derived therefrom. It is our job at the Bureau to try to understand and to develop the technical aspects of these devices and to provide that information to the officials who will make those decisions.

Senator RANDOLPH. Is there a role that Congress might play in recommendations that could improve the activities of the Center for Fire Research? Is there any coordination that we could bring to bear?

Mr. LYONS. Well, this is a personal opinion, Senator, and not that of the Bureau of Standards. My own view is that the Congress wrote a very good act in 1974 which was studied very carefully, which was preceded by the work of a Presidential commission on the subject which had wide representation from affected communities.

In looking at the Federal Fire Prevention and Control Act, as far as the National Bureau of Standards is concerned, I think it is eminently satisfactory. It is very broad and gives us a good charter to move ahead on all the technical research fronts.

Senator RANDOLPH. I am not sure that this is too important, but I was just thinking as I listened to the testimony, in connection

with the residential fires and the fatalities, I looked back and found that during a 7-year period over two-thirds of the 7,288 deaths that were reported, Chairman Quayle, occurred between the hours of 8 p.m. and 8 a.m. Now the importance is not very clear to me, but generally the impact of fires is after dark. Is that true?

Mr. LYONS. I think it is important, Senator. I wouldn't downgrade the statistic you reported at all. It is my firm impression that the vast majority of the people who die in fires are in some way very vulnerable. Those come in a number of different categories: Very old people; very young people, let's say less than age 6; people who are infirm, handicapped in one way or another; people who may be under the influence of alcohol or drugs; and people who are asleep. The smoldering fire that I discussed is insidious; it is a silent killer. There is no heat, no flame. However, most people who die are not awake, they are not in good health, and they are not fully aware. Therefore, when you cite figures that typically people die more at night than in the daytime, that reinforces the insidious nature of fire.

Senator RANDOLPH. Well, I thank you very much.

Thank you, Mr. Chairman.

Senator QUAYLE. Thank you, Senator Randolph.

Thank you very much for the testimony.

Senator Randolph, may I inquire of your schedule this morning? I have been managing this amendment that is on the floor now, and I have been contacted to come over there posthaste. Is your schedule convenient to take the testimony of these next three witnesses?

Senator RANDOLPH. Well, I certainly would want to do that. This is not the time for me to make a speech again about the necessity for what I call legislative days and committee days, but it is a constant pulling and hauling at the membership that they be on the floor and they be here. Sometime perhaps we will come to grips with that problem and really settle it. I never could get Members to vote in the Senate from their desks; I was defeated on that last year. Maybe if I am here for another 20 years, I might—[Laughter.]

Senator QUAYLE. Well, there are some of us that would like that.

Senator RANDOLPH. Forgetting frivolity, I will try to stay with it as long as I can.

Senator QUAYLE. I appreciate your cooperation, and you are absolutely right. I did not anticipate this coming up at this particular time. As a matter of fact, I had planned on being here and being able to ask a few more questions, and wish I could. However, when the chairman of the committee calls and says, "Look, you are managing this. You managed it yesterday. You get over to the floor," as a former chairman you know what those of us on the back bench do. We abide and act with great dispatch in trying to be accommodating.

I thank the Senator.

Senator RANDOLPH. Since Mr. Brooke is a West Virginian, I know we will get along well together. I advise they come quickly.

Senator QUAYLE. Mr. Brooke, Mr. Gilkey, and Mr. Flucker, please come forward. I apologize that I must leave. Thank you very much.

Senator RANDOLPH [acting chairman]. I will ask all of the panel members at the beginning, even before testimony, to identify themselves. Mr. Brooke, would you do that?

Mr. BROOKE. I am Richard Brooke of Borg-Warner Chemicals, representing the Society of the Plastics Industry, and with me is Dr. Michael O'Mara from the B.F. Goodrich Chemical Co., in Cleveland, Ohio.

Mr. GILKEY. I am Herbert Gilkey. I am director of codes and government liaison for the Sheet Metal and Air Conditioning Contractors National Association.

Senator RANDOLPH. Thank you very much.

Mr. FLUCKER. I am Ron Flucker. I work for United States Steel. I am here representing the American Iron and Steel Institute as chairman of the construction codes and standards committee. With me is Richard Gewain, member of the AISI staff.

Senator RANDOLPH. The Iron and Steel Institute?

Mr. FLUCKER. Yes, sir.

Senator RANDOLPH. You work with Bud Tucker, then?

Mr. FLUCKER. Well, I work for United States Steel.

Senator RANDOLPH. Is that everyone?

Mr. FLUCKER. Yes, and this is Dick Gewain.

Mr. GEWAIN. I am Richard Gewain. I am the chief fire protection engineer for American Iron and Steel Institute.

Senator RANDOLPH. Thank you so very much.

Mr. Brooke, if you will be our first witness, it is proper for me to say that the Borg-Warner chemicals facilities, their international headquarters are—and you correct me if I am wrong—centered in West Virginia at Parkersburg and Morgantown with some 2,000 employees. I am not sure of the breakdown between the two locations but I will say for you, and you won't have to say it, that even though you are identified in this way with West Virginia, you do have plants in Illinois, California, Mississippi, Louisiana, and overseas in Canada, Japan, Australia, Scotland, and the Netherlands.

We are very glad to have your testimony. Thank you very much.

Mr. BROOKE. Thank you, Senator Randolph.

Senator RANDOLPH. Are you a major manufacturer of plastics materials?

Mr. BROOKE. Yes, we are.

STATEMENT OF RICHARD C. BROCKE, BORG-WARNER CHEMICALS, INC., REPRESENTING THE SOCIETY OF THE PLASTICS INDUSTRY, INC., ACCOMPANIED BY MICHAEL O'MARA, B. F. GOODRICH CHEMICAL GROUP

Mr. BROOKE. Senator Randolph and other members, I am here on behalf of the Society of the Plastics Industry as chairman of the SPI's Coordinating Committee on Consumer Safety, which was established in 1970 to address the combustibility issues. SPI is the principal trade association representing the plastics industry. It is composed of more than 1,200 corporate members accounting for more than 75 percent of the sales of plastics in the United States.

With me is Dr. Michael O'Mara, the vice president of research and development of B. F. Goodrich in Cleveland, Ohio. Dr. O'Mara will join me in responding to questions you may have, Senator.

Senator RANDOLPH. Thank you.

Mr. BROOKE. The plastics industry is pleased to share with you our thoughts on the dimensions of the fire safety problem in the United States and to discuss what is being done to control fires. Most materials which are an integral part of our lives and society are combustible. As you have heard before, these include such products as wood, cotton, wool, leather, as well as synthetic products such as plastics.

Knowing that our products, like others, are combustible, our industry has done more than any other industry over the last three decades to encourage research and establish codes and standards to improve fire safety. Our industry has spent millions of dollars on fire research, and is working with various Federal and State agencies to determine how we can further reduce the incidence and severity of fires.

Some critics of the plastics industry have incorrectly maintained that the use of plastics has led to an increase in fire deaths. The record shows that fire deaths are declining at the same time use of our plastics materials is accelerating. Thus, while plastics have significantly improved the quality of life in this country, the dramatic increase in the use of plastics has not exacerbated the fire problem.

If we attempt to analyze why the fire death rate is decreasing, we find the following: There is now widespread use of smoke detectors. We are replacing older buildings with safer structures. New materials are more resistant to ignition. There is expanded fire safety education. There are automatic sprinklers; and last but not least is improved techniques for firefighters, their training and the equipment they use.

To the best of our knowledge, no major U.S. fire disaster has resulted in loss of life where modern building codes have been followed or where operating smoke detectors and sprinklers have been present. However, more must be done and our industry will continue to promote fire safety.

In the last 10 years, increasing attention has been paid to the problem of combustion toxicity, including development of various laboratory tests and post mortem examination of fire victims. Most of this work has verified that carbon monoxide, produced by all burning materials, is the principal killer in fires. Today's common combustibles are made from a wide variety of materials and the components of smoke are, in turn, somewhat different than was historically the case.

In the early 1970's work was begun to determine whether this difference in smoke composition meant that smoke was now more toxic and more hazardous to breathe. This laboratory research demonstrated that toxic products of combustion is a universal problem with all combustibles and, in general, synthetic and natural products are equivalent. We are just reaffirming here the statement that Dr. John Lyons from the National Bureau of Standards made earlier from his agency's studies.

Senator Randolph, this hearing has been valuable in bringing to the attention of the Senate and the people of the United States many of the interests that are dealing with fire safety. We have the following recommendations as to how we can continue to reduce fire loss in this country: We need to continue our education

program; we need to educate the general public on fire safety. We need to encourage the use of smoke detectors in all homes and commercial buildings. We need to encourage the use of sprinklers in residential and commercial buildings. We need to continue to support the basic research that is being done at the National Bureau of Standards, and we need to continue the excellent fire-fighting training that is going on in this country at the present time.

It has become clear that reducing fire deaths will depend largely upon early detection and early suppression of fires while they are still small. We have heard earlier that only two-thirds of residences in the United States have smoke detectors. We need to get the message to that last one-third as to why they should have a smoke detector.

Mr. Chairman, Senator Randolph, the Society of the Plastics Industry and its 1,200 corporate members are committed to the concept of improving fire safety in the United States. Our industry has been involved, and we will continue to be involved.

Thank you.

[The prepared statement and responses of Mr. Brooke to questions submitted by Senator Hatch follow:]

The Society of the
Plastics Industry, Inc.



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(202) 628-0270

STATEMENT OF

RICHARD C. BROOKE

THE SOCIETY OF THE PLASTICS INDUSTRY, INC.

BEFORE THE

COMMITTEE ON LABOR AND HUMAN RESOURCES

U.S. SENATE

on

FIRE SAFETY IN THE UNITED STATES

July 19, 1983

Mr. Chairman and members of the Committee, my name is Richard C. Brooke and I am the Section Manager of Material Sciences and Regulatory Affairs at Borg-Warner Chemicals, Inc. in Parkersburg, West Virginia. I appear here today on behalf of The Society of the Plastics Industry, Inc. (SPI) as Chairman of SPI's Coordinating Committee on Consumer Safety, which was established in 1970 to address combustibility issues.

SPI is the principal trade association representing the plastics industry. It is composed of more than 1,200 corporate members accounting for more than 75 percent of the sales of plastics in the United States. SPI's members include processors, convertors, raw materials suppliers, and manufacturers of machinery and molds used to make plastics.

With me today is Dr. Michael M. O'Mara, Vice President of Research and Development for the BF Goodrich Chemical Group in Cleveland, Ohio. Dr. O'Mara will join me in responding to any questions you may have.

The plastics industry is pleased to be here today to share with you our thoughts on the dimensions of the fire safety problem in the United States and to discuss what is being done to control accidental fires.

Most materials which are an integral part of our lives and society are combustible. These include natural products such as wood, cotton, wool, and leather, as well as synthetic products such as plastics. We are dependent upon combustible materials for the clothing we wear, the paper we use in our books and newspapers, the wood we use in constructing our homes, the mattresses upon which we sleep, the furnishings in our homes, the fuel to heat our homes, etc.

The plastics industry has been and continues to be a major force in technological innovation. We have developed products that are critical to the success of our national defense, our aerospace programs, and our energy conservation efforts. Moreover, plastics improve the comforts of life for nearly every citizen in this country. Our products have been to the moon and to the depths of the oceans. We are proud of our accomplishments.

The use of plastics in the United States has increased significantly in the last thirty years. In 1952 this country produced approximately two billion pounds of plastics. By 1982 the U.S. produced more than 35 billion pounds per year, more than a seventeen-fold increase.

We expect the uses of plastics in our living environment to continue to grow because plastics have contributed to a substantially changed and improved lifestyle. Plastics have solved problems that in the past prevented the marketing of better building insulation, shatter-proof glazing, lightweight and long-lasting cushioning, damage-resistant surfaces, fuel-efficient modes of transportation, shock-resistant tools, long-lasting wiring and cable insulations, weather-resistant coatings, corrosion-resistant water pipe, and medical devices, such as the artificial heart.

Knowing that our products, like all others, are combustible, our industry has probably done more than any other industry over the last three decades to encourage research and establish codes and standards to improve fire safety. Our industry has spent millions of dollars on fire research and is working with various federal and state agencies to determine how to reduce the incidence and severity of accidental fires, the subject of todays hearings.^{1/}

^{1/} Attached to this statement is an appendix detailing some of the plastics industry's contributions to fire safety.

Some critics of the plastics industry have incorrectly maintained that the use of plastics has led to an increase in fire deaths to human beings. Yet, the record shows that fire deaths declined during the period when plastic's use was accelerating. From 1971 through 1981, a period when annual production of raw materials for plastics nearly doubled, the fire death rate in the United States decreased 25 percent--from 43.7 deaths per million in 1971 to 33.1 per million in 1981.^{2/} Thus, while plastics have significantly improved the quality of life in this country, the dramatic increase in the use of plastics has not exacerbated the fire problem.

The major reasons for the dramatic decline in the death rate from fires are as follows:

- o Smoke detectors are now present in approximately 2/3 of American homes.
- o Older buildings have been replaced by structures with newer and safer designs reflecting modern code provisions.
- o New materials used in building and furnishing our homes are more resistant to ignition.

^{2/} Benjamin and Clark, Fire Deaths Causes and Strategies of Control, May, 1983.

- Expanded fire safety education has alerted the population to methods of preventing fires and ways of escaping if they occur.
- Automatic sprinklers have decreased the severity of many fires.
- Improved fire fighting and training have made fires more manageable and rescue operations more successful.

More must be done and SPI will continue to promote fire safety. Our members continue to be involved in public education programs to prevent loss of life through fire. It is also essential that the spread of misinformation about the causes of fire death be corrected.

Multiple death fires are major news items that receive extensive coverage either as the lead article on nationwide television or as the banner headline story in the local newspaper. In many of these instances these tragedies have been dramatized as "plastics fires." These attempts result in generating public pressure which diverts attention from the important task of studying the real causes of fires and applying that knowledge to minimize future occurrences.

An examination of some of our recent tragic fires--the MGM Grand Hotel in Las Vegas,; the Westchase Hilton Hotel in

Houston; Stouffers Inn in Harrison, New York; and the Beverly Hills Supper Club in Southgate, Kentucky--demonstrates the critical role that building code violations or improperly trained service personnel play in these fires. To the best of our knowledge no major United States disaster has resulted in loss of life where modern building codes have been followed or where operating smoke detectors and sprinklers have been present.

However, whether we are discussing sensationalized large fires or the fires that occur in 1- and 2-family dwellings and cause the largest number of fire deaths, fire professionals have long known that most fatalities are caused by the products of combustion. More than thirty years ago the National Fire Protection Association in its first published study on the effect of smoke stated:

The large number of fire casualties from the inhalation of the noxious products of combustion . . . has long been of most serious concern to the fire protection fraternity.

In the last ten years increasing attention has been paid to the problem of combustion toxicity, including development of various laboratory tests and post-mortem examination of fire victims. Most of this work has verified that carbon monoxide, produced by all burning organic materials, is the principal killer in fires. This, of course, can be complicated by a wide range of other factors such as smoke particulates, alcohol, and infirmities such as age or heart disease.

Today's common combustibles are made from a wide variety of materials, and the components of smoke are, in turn, somewhat different than was historically the case. In the early 1970s, work was begun to determine whether this difference in smoke composition meant that smoke was now more hazardous to breathe. Of particular interest was the question of whether synthetic materials might produce more toxic fumes than would natural products. Several research test methods, which exposed laboratory animals to smoke from burning or decomposing materials, were developed for the limited purpose of addressing this issue. This laboratory research demonstrated the similarity between the toxic effects caused by burning natural and synthetic materials.

Recently, the question has been raised as to whether laboratory scale combustion toxicity tests can be used to rate and rank materials for regulatory purposes so as to increase human safety. As work on this question has progressed, two issues emerged which now dominate discussions of smoke toxicity. The first is that different tests often produce diverse results in ranking materials. The second issue is that the effects of smoke depend not only on specific toxicity but also on how much of the product is involved in the fire.

With respect to the problem of diverse results, what combustion products are produced and the circumstances in which the test subjects encounter them determine toxicity. The conditions of combustion chosen for the test can have a profound effect on the combustion products produced. Similarly, the method of animal exposure determines whether the animals breathe the products all at once or one at a time. It is increasingly recognized that limiting the use of or approval of a material based simply on the results of one combustion toxicity test method is inappropriate.

The effects of smoke, the second issue, can best be understood by way of an example. Consider two different materials intended for the same use. Tests show material A to produce smoke that is twice as toxic as material B. But if material A burns half as fast as material B it will produce half the smoke and the actual toxic effects of the two materials will be equivalent. In fact material A may be preferable overall because its slower burn rate means it will also contribute less to other aspects of fire hazard. In this hypothetical example, the comparison of overall safety is readily made.

However, in practice, the comparison is an extremely complex task. Important factors in a valid risk assessment must include ease-of-ignition, rate of heat release, rate of flame spread, and exposed area of the material. Unfortunately,

science has not yet developed a standard procedure for analyzing these factors.

Small-scale laboratory tests are, at the present time, inappropriate for regulatory purposes because they do not replicate actual fire conditions. For that reason, the results can, therefore, be misleading. Although accumulating results of small-scale tests, in the absence of more meaningful data, might appear worthwhile, this course of action could give the public a false sense of security. Moreover, as a result of relying on a limited understanding of actual fire performance, there is a significant danger that real efforts at improving fire safety will be impaired. Such reliance would reduce safety because of a failure to understand properly the subtle and complex inter-relationships present in actual fires.

The record amply demonstrates that this country is on the right track in reducing mortality and injury from fire. Let me give some examples of how the plastics industry has contributed to the cause of fire safety.

1. In 1977 SPI and the U.S. Fire Administration (now part of the Federal Emergency Management Agency (FEMA)) jointly funded a gas sampling of fires in Boston. Boston fire fighters went into 300 actual fires with samplers devised by the Harvard University School of Public Health. This study

confirmed that carbon monoxide was the most common and serious hazard at a fire. It also showed, for the first time, that acrolein, an irritant formed by burning cellulosic materials^{3/} was present in life-threatening concentrations in real fires. As a consequence of that study, the Boston Fire Department instituted a mandatory mask rule for fire fighters dealing with structural fires. Thereafter, inhalation injuries to Boston fire fighters dropped 80 percent.

2. In the 1970s, there were a number of fire deaths in various jails and prisons in which inmates had set fire to polyurethane foam mattresses and/or padded cells containing cellular foam materials. The industry alerted prison officials to this problem and pointed out that foam plastics cushioning--while resistant to smoldering ignition from such sources as cigarettes--could not withstand arson. Subsequently, the industry

^{3/} Examples of cellulosic materials are wood, cotton, and paper.

developed a family of flexible foam products which are resistant to the types of open flame ignition that would be encountered in such arson situations.

3. The plastics industry has been working closely with the Upholstered Furniture Action Council (comprised of upholstered furniture manufacturers) and the Consumer Product Safety Commission in the development of upholstered furniture construction which is more resistant to smoldering sources of ignition, such as cigarettes.
4. The plastics industry cooperated with the bedding industry and the Department of Commerce in the 1970s to develop a standard (now called CPSC FF 4-72) establishing criteria to make mattresses more resistant to smoldering ignition. CPSC has deemed this program highly successful in reducing bedding fires.
5. Currently The Society of the Plastics Industry, Inc. is working with allied trade associations^{4/} on educational efforts to

^{4/} Man-Made Fiber Producers Association, Inc.; Carpet and Rug Institute; and American Textile Manufacturers Institute, Inc.

expand the use of smoke detectors and sprinklers in residential and commercial buildings.

6. The industry has developed plastic electrical conduit which has led to improved fire safety. Such conduit resists corrosion, cannot cause short circuits, and will not conduct electricity.

Mr. Chairman and members of the Committee, this hearing has been valuable in bringing to the attention of the Senate and the people of the United States many of the interests that are dealing with fire safety. We are submitting as a part of this statement the following recommendations for addressing the hazards:

- Educate the general public on fire safety.
- Encourage the use of smoke detectors in all homes and commercial buildings.
- Encourage the use of sprinklers in residential and commercial buildings.
- Continue support of basic research at the National Bureau of Standards.
- Improve fire fighter training.

It has become clear that reducing fire deaths will depend largely on early detection and the suppression of fires while they are still small. It is estimated that only 2/3 of

American households had one or more smoke detectors. The remaining third of American households must be made aware of the need for smoke detectors.

Mr. Chairman and members of the Committee, The Society of the Plastics Industry, Inc. and its 1,200 corporate members are committed to the concept of improving fire safety in the United States. We are more than willing to assist and encourage reasonable measures to reduce the incidence of accidental fire and the attendant loss of life, injuries and property which have been associated with it.

Thank you. We will be happy to respond to any questions the Committee may have.

APPENDIX A

The Society of the Plastics Industry, Inc. and its members have worked closely with the major model building code organizations--International Conference of Building Officials (IBCO), Building Officials and Code Administrators International, Inc. (BOCA), and Southern Building Code Congress International, Inc. (SBCCI)--on provisions covering the use of plastics in such applications as light-transmitting panels, glazing, insulation, plumbing systems, ceiling panels, siding and roofing.

SPI has worked with the National Electric Code organizations of the National Fire Protection Association on provisions for electrical wiring and conduit. To establish parameters for

the many and varied uses for our materials, our members sit on many other committees of such standards setting organizations as the National Fire Protection Association, the American Society for Testing Materials, and the International Standards Organization.

In recent years our industry has supplied research associates to work with the Center for Fire Research at the National Bureau of Standards.

Our industry has sponsored combustibility symposia and fire service seminars and has worked closely with such fire service organizations as the International Association of Fire Chiefs, The International Society of Fire Service Instructors, The International Association of Fire Fighters and others to address the concerns of the fire community.

For example, in June, 1983, more than 190 members of the California Metropolitan Fire Chiefs Association attended a seminar on fire and plastics sponsored by SPI. In February, 250 New Jersey fire officials attended a seminar on plastics and fire sponsored by the State of New Jersey and conducted by SPI.

Ever since the Consumer Product Safety Commission (CPSC) was formed, SPI has cooperated with members of the CPSC staff in addressing the fire hazard to consumers.

SPI has funded basic research for the development of combustion toxicity methods.

The Society of the
Plastics Industry, Inc.



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August 11, 1983

Honorable Orrin G. Hatch, Chairman
Committee on Labor and Human Resources
United States Senate
SD-428 Dirksen Senate Office Building
Washington, D.C. 20510

Dear Mr. Chairman:

On behalf of the members of The Society of the Plastics Industry, Inc., thank you for permitting me to appear for the association before the Senate Labor and Human Resources Committee on July 19, 1983, to discuss the causes of fire and the ways in which fire safety can be improved. The plastics industry has long recognized the serious nature of this issue and will make every effort to assist the Committee, as we have aided government agencies in the past.

Your letter of July 26 contained additional questions on the fire safety issue which, because of time limitations at the hearing, could not then be addressed. Set forth below are my responses:

Q. 1) CAN YOU EXPLAIN WHAT IS BEING DONE TO PROTECT THE PUBLIC FROM TOXIC COMBUSTION PRODUCTS IN BUILDINGS?

Fire safety is being improved through education and the development of better designed buildings and materials.

Education in prevention and escape procedures is perhaps the ultimate answer to fire hazards problems. As is discussed in detail in response to questions five and seven, much is being done on this score. Special emphasis is being placed on early training in the school system. The plastics industry is playing an increasingly important role in promoting public and fire fighter educational programs.

The other primary means of protecting the public from toxic combustion products is to reduce ignition and flame spread. The most efficient method for accomplishing this goal is to work with state and local authorities to revise and update the building and fire codes so that they reflect the latest advances in fire safety engineering. Once a fire has started, smoke detectors, sprinklers, duct systems and building design itself can reduce the severity of the fire and/or provide for rapid escape.

Undoubtedly, the most encouraging development in fire safety in recent years has been the increasing installation of smoke detectors which provide building occupants with an early warning of danger. This permits persons to evacuate a fire scene and enables fire fighters to respond to the danger while a conflagration is still at an early stage. Equally encouraging are the current efforts to promote the use of sprinklers in residential buildings.

The role of ventilation systems and building design should not be ignored. Improved engineering in buildings has resulted in the saving of lives. As the National Association of Sheet Metal and Air Conditioning Contractors has testified, when sprinklers cannot be installed, duct systems should be designed and constructed to prevent the movement of smoke and other combustion products into parts of the building not involved with the fire.

Improved fire exits have also been developed. For example, at Disney World, exits directly to the outdoors from each floor have been designed for most of the hotels. This ensures that in the event that a fire occurs, occupants will be able to escape before toxic fumes become a problem.

In addition, unique fire escapes have been designed for the second and third floors of residences. When a fire occurs, these ladders, which fold flat against the wall of the house, can be lowered to the ground.

Great progress is being made to make buildings safer in the event that a fire occurs. Nevertheless, we are all aware that more can and is being done.

Q. 2) DO CERTAIN PLASTICS LIKE PVC (POLYVINYL CHLORIDE) BURN FASTER THAN OTHER TYPES OF PLASTICS? DOES THIS PRESENT A GREATER DANGER?

The burning characteristics of different types of plastics vary widely, depending on both the composition and the form of the plastic. For example, some foamed plastics that are used as insulation in buildings can burn quite rapidly when ignited by an open flame. For this reason, building codes require a thermal barrier between the interior of a room and this type of plastics insulation.

Polyvinyl chloride (PVC) is one of the more difficult materials to ignite. Conduit made of PVC will not burn unless exposed to a continuous external flame source. Thus, PVC can, in fact, prevent fires in electrical systems. Indeed, its use first became a major one at the request of the Navy in World War II. The Armed Forces made known the requirement for a safer wiring cover to the plastics industry and PVC has been a widely used material ever since.

While many plastics are resistant to ignition, we recognize that once certain materials are ignited, they will burn more rapidly and generate more smoke than cellulosic materials. For that reason, we have developed and are continuing to improve fire retardant plastics materials that burn more slowly and are, therefore, less hazardous than other combustible materials.

Q. 3) DO YOU FEEL COMBUSTION TOXICITY CRITERIA SHOULD BE INCLUDED IN MAJOR BUILDING CODES?

No. Including combustion toxicity requirements in major building codes is inappropriate because different tests often produce diverse results in rating materials. What combustion products are produced and the circumstances in which the test subjects encounter them determine toxicity. The conditions of combustion chosen for the test can have a profound effect on the combustion products produced. Similarly, the method of animal exposure determines whether the animals breathe the products all at once or one at a time. It is increasingly recognized that limiting the use of or approval of a material based simply on the results of one combustion toxicity test method is irresponsible.

Moreover, the data obtained from these tests might give the public a false sense of security and could impair the development of better engineering and test methodology. For these reasons, these small scale tests should not be used for regulatory or code purposes. The Federal Trade Commission recognized this when it issued a consent decree in 1974 which prohibited plastics manufacturers from making representations about the safety of their products based on small scale tests.

Q. 4) WHAT TYPE OF COMBUSTION-TOXICITY TEST DOES THE SOCIETY OF THE PLASTICS INDUSTRY RECOMMEND USING TO SET FIRE SAFETY STANDARDS FOR MATERIALS?

At the present time, there is no test we can recommend and we know of no one else who can recommend a test that will pass muster under peer review.

It is essential to remember that combustion toxicity is but one of a number of interrelated factors that determines the risks a given material will pose. This is known as the science of risk assessment. Such factors as ease of ignition, rate of heat release, rate of flame spread and the exposed area of the material must be factored into any test. In addition, a valid assessment must consider such fire safety measures as automatic detection, warning and suppression, compartmentalization, pressurization and smoke movement.

As we have stated previously, no combustion toxicity test is universally acceptable to be used in such an overall risk assessment. SPI will continue to support efforts to develop scientifically validated tests that will aid in the solution of fire prevention and management problems.

Q. 5) CAN YOU EXPLAIN WHAT TYPES OF PUBLIC EDUCATION PROGRAMS THE SOCIETY OF THE PLASTICS INDUSTRY HAS BEEN INVOLVED IN TO PROMOTE FIRE SAFETY?

Over the years, we have held annual and special symposiums on fire safety for our members which have been open to the public. We have also helped to finance public education programs conducted by such organizations as the National Fire Protection Association (NFPA), Underwriters Laboratories, the National Safety Council, the Consumer Product Safety Commission, the International Association of Fire Chiefs (IAFC) and the Federal Emergency Management Administration (FEMA) through our own research efforts and financial contributions.

For example, FEMA and SPI jointly sponsored a study of actual fire gases in conjunction with the Boston Fire Department and the Harvard University School of Public Health. As a result of these pioneering experiments, the City of Boston adopted a requirement that fire fighters wear protective masks before entering a burning structure. Since this requirement was imposed, there has been a dramatic decrease in inhalation injuries.

In conjunction with the NFPA, SPI developed a training program for fire fighters entitled "The Fire Fighter and Plastics in a Changing Environment." More than 5,000 of these literature-slide programs were used by the fire services.

In recent months, SPI has sponsored seminars for fire officials in Alaska and northern California. We are committed to continuing these educational efforts.

Q. 6) CAN YOU EXPLAIN YOUR WORK WITH THE ALLIED TRADE ASSOCIATIONS TO EXPAND THE USE OF SMOKE DETECTORS AND SPRINKLERS IN RESIDENTIAL AND COMMERCIAL BUILDINGS?

SPI regularly coordinates its efforts in the fire safety area with such allied industry organizations as The Man-Made Fibers Producers Association, Inc.; the Carpet and Rug Institute; and the American Textile Manufacturers Institute, Inc.

This group of organizations commissioned a well-known independent code expert, Mr. Don Belles, to conduct a thorough investigation of the uses of and potentials for smoke detectors and sprinklers in contributing to fire safety. FEMA relied on the document Mr. Belles produced as source material for its booklet entitled "An Ounce of Prevention," which urges consumers to install smoke detectors and sprinklers. It will soon be distributed to the public. We recommend the booklet to your Committee as an example of the type of public education tool that can have a substantial impact on fire safety in the United States.

Q. 7) HOW DO YOU SUGGEST WE BETTER EDUCATE THE GENERAL PUBLIC ON FIRE SAFETY?

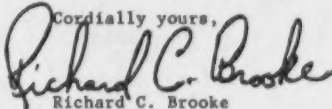
The efforts of the fire services, supported by the National Fire Prevention Association, the Federal Emergency Management Administration, the International Association of Fire Chiefs, the International Association of Fire Fighters and others, in bringing fire safety messages to communities at the local level have certainly started an encouraging trend toward reduced fire losses. We have seen the fire death rate decrease 25 percent in a decade. But more needs to be done and The Society of the Plastics Industry is committed to continuing its efforts to upgrade fire safety even further.

We believe that the most effective method for educating the public is to encourage fire fighters to meet with primary and secondary age school children. The national exposure provided through such activities as NFPA's "Learn Not To Burn" video program, supported by direct fire service education at the local level -- particularly to school-age children -- can greatly assist in raising the level of fire-safety consciousness in this country.

Furthermore, the media should become actively involved. Fire safety messages should be aired frequently in prime time for adults and on Saturdays mornings for children. It is clear that we have the information available to improve fire safety dramatically. However, the information must be communicated to the public more efficiently.

I hope that you and the Committee will find these responses helpful in addressing this important issue. Thank you again for allowing us to participate at the hearing. If you have any additional questions or if we can be of any further service, please do not hesitate to contact me.

Cordially yours,



Richard C. Brooke

Chairman

Coordinating Committee on Consumer Safety

Senator RANDOLPH. Now all the members of your association, are they manufacturers of plastics who form the constituency?

Mr. BROOKE. They are not only manufacturers of plastics, of the raw materials, but they are compounders who take the raw plastic and convert it into a sheet or pellets. They are manufacturers of machinery used to process the plastic. They are manufacturers of the molds needed for injection molding of our products. Therefore, our trade association is more than just the manufacturers of the raw plastics.

Senator RANDOLPH. Mr. Brooke, I have been thinking and just wondering if you might be interested in looking into something that perhaps you have already looked into, and that would be to establish a data bank on toxic gases. These are released, as we know, from various materials as they burn. Is that not right?

Mr. BROOKE. Toxic gases are indeed released from everything that burns.

Senator RANDOLPH. Yes; is there an effective way to identify such fires?

Mr. BROOKE. Let me come back to your first question regarding the data bank.

Senator RANDOLPH. All right.

Mr. BROOKE. Our industry, as well as other groups in this country, has spent a considerable amount of effort in attempting to develop a toxicity test which we could relate to real fires. We are still in the process of developing a test which will be universally accepted. Our general feeling is that before we start developing a data bank, we should have an appropriate test which is acceptable by all and especially the people in this country who make the major decisions regarding risk benefits. Does that answer your question?

Senator RANDOLPH. Yes; that certainly is helpful to me.

Now this final question: I presume you are familiar, or at least I will ask you if you are familiar with a fire training program in West Virginia at Mountwood Park near Parkersburg?

Mr. BROOKE. Yes.

Senator RANDOLPH. I have had a long interest, as you know, in that institution. Now what about the development there of possible programs or a program?

Mr. BROOKE. Senator Randolph, we are very proud of that accomplishment. At Mountwood Park I think there are approximately 62 acres which have been set aside for this fire training effort. It is not only for the firefighters in West Virginia but it is for the firefighters in the surrounding States.

Our industry has played a major role in seeing that this firefighter training activity has come about. We are proud of that. We think that the program will begin later on this year, and we look forward to the firefighters from the surrounding areas to come in and receive additional training there. We think efforts of this nature are extremely important in this country in helping to lower the fire death rate, as well as fire losses.

Senator RANDOLPH. Well, I appreciate your knowledge in the use of the Mountwood Park which, of course, is a beautiful area. I am particularly interested in the program you have mentioned and also the work that we are doing there for the retarded, physically

and mentally, the programs having these younger and older people to be productive in ways that they are being productive.

I think these are the kind of dollars that are often difficult to have Federal funding for. We have many types of funding but the Mountwood Park could be visited by many, many people, and some of the programs there would be enlightening. Thanks for just touching on this one phase or two phases of what is done at that park.

I think that is all, Mr. Brooke, and I thank you very much.

We might, as I am sure we will, do what Senator Hatch has in a sense asked me to announce as a part of the record, that especially he and Senator Quayle, and yes, other members of the committee, they as they have the opportunity through their staffs and their own efforts to focus attention—and perhaps many of them have already—we would like to have submission of questions from the chairman and other members to not only those who sit on the present panel but to the panels that preceded you. I want the record to show that you could well expect questions by mail. Would that be agreeable to all of you, to respond as quickly and as factually as possible?

Mr. GILKEY. It certainly would, Senator Randolph.

Senator RANDOLPH. Mr. Gilkey, you are director of codes and Government liaison efforts, as you have indicated, with the National Association of Sheet Metal and Air Conditioning Contractors. Would you speak at this time?

STATEMENT OF HERBERT T. GILKEY, DIRECTOR OF CODES AND GOVERNMENT LIAISON, SHEET METAL AND AIR-CONDITIONING NATIONAL ASSOCIATION

Mr. GILKEY. Thank you, Senator.

SMACNA is a national trade association of approximately 2,400 members who are sheet metal contractors. These contractors construct and install commercial, industrial, and residential heating, ventilating, and air-conditioning systems, and are also concerned with architectural sheet metal, solar energy systems, and energy management.

Those preceding me today have discussed the causes of fires, fire prevention, the control of fires, the deadly constituents which are present in combustion products, and research which is underway to improve knowledge and understanding of how fires spread and how fire and smoke can be controlled and contained.

As an aside, Senator, SMACNA is proud to be a cosponsor of some of the studies conducted at the Center for Fire Research in the National Bureau of Standards. The Center is an important contributor to improved understanding of life safety in fire situations. Because of the diverse nature of the construction industry in this country, the Center has become a vitally important coordinating force in this research. We hope that its programs can be continued and will be strengthened.

We at SMACNA have concerns that are somewhat different from those of others who have appeared this morning. Our contractor members construct and install the duct systems which convey treated air to all parts of a building and which return the air for

retreatment or for exhaust to the outdoors. They do this following designs and specifications provided by the design professionals, the architects and the mechanical engineers.

Duct systems can, if properly designed, if equipped with fire and smoke dampers and if properly controlled, prevent the movement of smoke and other combustion products into parts of a building not involved with a fire. Conversely, improper use of a duct system under fire conditions can speed the spread of combustion products and of the fire itself. The difference between a duct system that prevents the spread of combustion products and one that either enhances or fails to retard this spread is a difference between life and death to people in a building.

Putting out a fire is the ultimate goal, of course. Sprinkler systems have proved effective in this, but they are designed to protect property, not to control the spread of smoke. It is smoke that kills, and smoke control systems protect lives.

Because of limited time, I shall address only three issues: The construction of the duct system; how and where smoke and fire dampers should be installed; and some systems operating considerations.

Each discussion will be brief and may make the situation seem simpler than it really is.

The construction of the duct system, the materials of which its different sections must be made, depends in part upon location within the building, whether or not the duct is piercing a fire-rated barrier, and the routine and emergency functions which that duct system is expected to provide. The basic standard used is NFPA 90A, the standard for the installation of air-conditioning and ventilating systems. Residential installations are covered by NFPA 90B, a standard for the installation of warm air heating and air conditioning systems. These NFPA standards are often supplemented or modified by local building codes.

NFPA 90A is very explicit in its requirements for enclosing vertical ducts in fire-resistive enclosures when they pass through floors of buildings, and for locating fire dampers in ducts where they pierce walls required to be fire-rated assemblies. Specifying these rated enclosures and fire damper locations is the responsibility of the system designer.

Specifying how a fire damper must be constructed and how it must function is not terribly difficult. It must close when exposed to air or combustion products of a specified temperature. It must not fail when exposed to higher temperatures, and the section of the duct in which it is located must stay in place so that the integrity of the fire-rated assembly—the fire wall, if you will—is maintained. Fire dampers, once actuated to close an opening that could allow a fire to spread, are not expected to be reset until after the emergency is over.

Smoke dampers are intended to restrict smoke spread within a building by either simply closing off potential smoke passageways when duct systems are not operating, or by serving to alter the operating conditions of the duct system to confine smoke conditions in a fire zone. Special use of HVAC systems for smoke control is a relatively new development, and designers, building officials, con-

tractors, building managers, and firefighters all have much to learn about using this new weapon in the battle for fire safety.

Maintaining smoke-free compartments and smoke removal are two functions that duct systems are uniquely capable of accomplishing. This sounds simple; it isn't, but it can and it has worked. Smoke control appears to be one of the most effective ways to deal with the combustible-stocked buildings we now occupy. As a matter of fact, some hotels pressurize their corridors slightly so that a fire in a room will be contained long enough for firefighters to arrive. This prevents the spread of fire and smoke, prevents panic, and saves lives.

We don't hear very much about the success stories. Every time such a system has saved lives, the success has been tentative. Something could have gone wrong, right up to the last moment. When a system has not done as well as expected and lives have been lost, the failure has usually been found to be a human one—perhaps an inadequate code enforcement, perhaps inadequate inspection or maintenance of the building and of its systems, perhaps a remodeling that did not consider fire safety, or something as simple as a door blocked open so that a corridor or stairwell could not be pressurized adequately. We must also remember that tragedies averted are frequently tragedies unreported.

In a very general sense, the concepts and principles of effective smoke control in building systems are fairly well understood. We know what we should try to do in designing such systems, and we understand most of the tools that we have to work with. The things that we don't know are immensely important, however, and great effort must be made to fill gaps in our understanding. Combustion products are not air, and they move in a building differently than air would move. Finally, how do we make the systems not only foolproof but also damn-fool proof? How do we protect against people-caused failures?

We need answers to these questions. It will take time and it will take effort but it can happen. I am sure, Senator Randolph, that the interest of this committee will cause this to happen sooner than it would have occurred if this hearing had not been held.

Thank you, sir.

[The prepared statement and responses of Mr. Gilkey to questions submitted by Senator Hatch follow:]

STATEMENT OF
SHEET METAL AND AIR CONDITIONING CONTRACTORS'
NATIONAL ASSOCIATION, INC.
ON
FIRE SAFETY
TO THE
COMMITTEE ON LABOR AND HUMAN RESOURCES
UNITED STATES SENATE

The Sheet Metal and Air Conditioning Contractors' National Association -- SMACNA -- is pleased to have this opportunity to provide information on the very important issue of fire safety. My name is Herbert T. Gilkey, SMACNA Director of Codes and Government Liaison. I am a registered professional engineer, and I have been associated with the heating, ventilating, and air conditioning industry since graduating from college.

SMACNA is a national trade association whose 2,400 members are sheet metal contractors. They construct and install commercial, industrial and residential heating, ventilating, and air conditioning systems. They are also concerned with architectural sheet metal, solar energy systems, and energy management.

Those preceding me today have discussed the causes of fires, fire prevention, the control of fires, the deadly constituents which are present in combustion products, and research which is under way to improve knowledge and understanding of how fires spread and how fire and smoke can be controlled and contained. It has been most informative.

As an aside, Mr. Chairman, SMACNA is proud to be a co-sponsor of some of the studies conducted at the Center for Fire Research in the National Bureau of Standards, an important contributor to improved understanding of life safety in fire situations. Because of the diverse nature of the construction industry in this country, the Center has also become a vitally important coordinating force in this research. We hope that its programs will be strengthened.

We at SMACNA have concerns that are somewhat different from those of others who have appeared this morning. Our contractor members construct and install the duct systems which convey treated air to all parts of a building, and which return the air for retreatment or exhaust to the outdoors. They do this following designs and specifications prepared by design professionals -- architects and mechanical engineers.

Duct systems can, if properly designed, if equipped with both fire and smoke dampers, and if properly controlled, prevent the movement of smoke and other combustion products into parts of the building not involved with fire. Conversely, improper use of a duct system under fire conditions can speed the spread of combustion products and the fire itself. The difference between a duct system that prevents the spread of combustion products and one that either enhances or fails to retard this spread is the difference between life and death to people in the building.

Putting out a fire is the ultimate goal, of course. Sprinkler systems have proved effective in this, but they are designed to protect property not to control the spread of smoke. It is smoke that kills, and smoke controls systems protect lives.

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- The construction of the duct system;
- How and where smoke and fire dampers should be installed;
and
- Some systems operating considerations.

Each discussion will be brief and may make the situation seem simpler than it really is.

The construction of the duct system -- the materials of which its different sections must be made -- depends in part upon location within the building, whether or not the duct is piercing a fire-rated barrier, and the routine and emergency functions which the system is to provide. The basic standard used is NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems", 1981 Edition. (Residential installations are governed by NFPA 90B "Standard for the Installation of Warm Air Heating and Air Conditioning Systems.") The NFPA Standards are often supplemented or modified by local building codes.

NFPA 90A is very explicit in its requirements for enclosing vertical ducts in fire resistive enclosures when they pass through floors of buildings and for locating fire dampers in ducts where they pierce walls required to be fire-rated assemblies. Specifying these rated enclosures and fire dampers locations is the responsibility of the system designer.

Specifying how a fire damper must be constructed and how it must function is not terribly difficult. It must close when exposed to air or combustion products of a specified temperature, it must not fail when exposed to higher temperatures, and the section of duct in which it is located must stay in place so that the integrity of the fire-rated assembly -- the fire wall, for example -- is maintained. Fire dampers, once actuated to close an opening that could allow fire to spread, are not expected to be re-set until the emergency is over.

Smoke dampers are intended to restrict smoke spread within a building by either simply closing off potential smoke passageways when duct systems are not operating or by serving to alter the operating condition of the duct system to confine smoke conditions in a fire zone. Special use of HVAC systems for smoke control is a relatively new development and designers, building officials, contractors and fire fighters all have to learn more about using this new weapon in the battle for life safety. Maintaining smoke-free compartments are two functions that duct systems are uniquely capable of accomplishing. This sounds simple; it isn't. But it can and has worked. Smoke control appears to be one of the most effective ways to deal with the combustibles-stocked buildings we humans occupy.

As a matter of fact, some hotels pressurize their corridors so that a fire in a room will be contained long enough for fire fighters to arrive. This prevents the spread of fire and smoke, prevents panic and saves lives.

We don't hear very much about the success stories. Every time such a system has saved lives, the success has been tentative -- something could have gone wrong right up to the last moment. When a system has not done as well as expected and lives have been lost, the failure has usually been found to be a human one -- perhaps inadequate code enforcement, inadequate inspection or maintenance of the building and its systems, a remodeling that did not consider fire safety, or something as simple as a door blocked open so that a corridor or stairwell could not be pressurized adequately. We must also remember that tragedies averted are frequently unreported.

In a very general sense, the concepts and principles of effective smoke control in building systems are fairly well understood. We know what we should try to do in designing such systems and we understand most of the tools that we have to work with. The things we don't know are immensely important, however, and great effort must be made to fill gaps in our understanding. There is still much to be learned about how fire starts and spreads. Combustion products are not air, and they move in a building differently than air would move. And finally, how do we make the systems not only fool proof, but also damn-fool proof -- how do we protect against people-caused failure?

We need answers to these questions. It will take time and effort, but it can happen. I am sure, Mr. Chairman, that the interest of this Committee will cause this to happen sooner than it would have occurred if this hearing had not been held.



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August 10, 1983

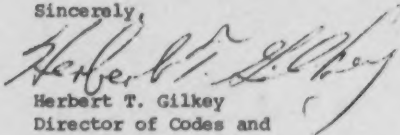
Honorable Orrin G. Hatch, Chairman
United States Senate
Committee on Labor and Human Resources
Washington, D.C. 20510

Dear Senator Hatch:

Attached are responses to the questions on fire safety which you sent me recently. I hope that the responses are clear and informative, and they will make the hearing record more complete.

SMACNA was pleased to have had the opportunity to testify at the recent hearing. We hope that our testimony has provided the Committee with a better understanding of how lives can be saved by controlling the spread of smoke within buildings.

Sincerely,


Herbert T. Gilkey
Director of Codes and
Government Liaison

Attachment

HTG/sb

cc: Don Clark
Harold Nepereny
Gregg Ward
John Stratton

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC.
HEADQUARTERS: 8224 OLD COURTHOUSE ROAD, VIENNA, VIRGINIA • 703-790-9890
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RESPONSE OF
HERBERT T. GILKEY
SHEET METAL AND AIR CONDITIONING CONTRACTORS'
NATIONAL ASSOCIATION
TO WRITTEN QUESTIONS ON
FIRE SAFETY
ASKED BY
HON. ORRIN G. HATCH, CHAIRMAN
UNITED STATES SENATE
COMMITTEE ON LABOR AND HUMAN RESOURCES

Question 1 -- CAN YOU EXPLAIN HOW DUCT SYSTEMS, IF PROPERLY DESIGNED, AND IF EQUIPPED WITH BOTH FIRE AND SMOKE DAMPERS CAN PREVENT THE MOVEMENT OF SMOKE AND OTHER COMBUSTION PRODUCTS INTO OTHER PARTS OF THE BUILDING NOT INVOLVED IN THE FIRE?

Answer -- At generation smoke is propelled from the source of ignition by pressure differences that are created by temperature differences. Smoke may also be moved about by pressure differences from other conditions that cause air currents to push it or mix with it. HVAC systems can increase or decrease smoke spread and fire spread by the way they control pressures in buildings.

The principal methods of preventing smoke spread include options of: 1) closing doors to compartmentalize the problem area; 2) venting it to the building exterior by creating openings in the exterior; 3) exhausting it using fan systems; 4) creating in safe-refuge zones and exit paths higher pressures than exist in the fire zone.

Centralized HVAC systems normally recirculate air instead of supplying 100% outside air and then exhausting it. If they are shut off and are not equipped with dampers that block smoke migration through them, they can boost smoke spread. If they are allowed to keep running normally they can actively contribute to smoke spread.

In the event of a fire, detection systems should cause HVAC systems to automatically switch to a proper operating mode or a suitable shutdown condition that is appropriate for the particular location of the fire. Otherwise, specially trained individuals should manipulate system controls to effectively deal with the specific fire and smoke situations. In either case air flow monitoring devices and damper blade position sensing devices may be necessary to confirm the true condition of the system.

Time is a vital element. Smoke can be a life-threatening situation before temperatures set off sprinklers or fire alarms. Of course, fire dampers are still necessary for heat responsive protection, but they may need special controls so that they do not inhibit the use of air systems for smoke control.

It is evident that electrical power must be available to run the HVAC systems in emergencies. Building communication and alarm systems also need to be functional so that panic is controlled and that well-intentioned-but-misguided individuals do not interfere with the HVAC system's ability to manipulate smoke spread by controlling pressures in the buildings. Occasionally systems that were designed for smoke control have been deactivated by someone who thought that cutting off the electrical power was the correct thing to do.

Fire fighters are now being trained to diagnose and adjust the condition of HVAC systems as effective weapon in smoke control. Even systems that were installed in older buildings and were not equipped with features that were engineered for smoke control can be used to enhance life safety.

Question 2 -- DOES THE IMPROPER USE OF A DUCT SYSTEM UNDER FIRE CONDITIONS OCCUR OFTEN? CAN YOU GIVE US SOME EXAMPLES OF FIRES WHERE THIS SITUATION OCCURRED?

Answer -- Although the spread of smoke and fire through duct systems is not uncommon, we do not know how often "improper use of the duct system" occurs. On the other hand, we do not know of any instances in which an engineered smoke control system which was correctly installed, well maintained and properly operated failed to contain the smoke and fire as it was designed to do.

There are, of course, many causes of system failures. These include improper design of the system in the first place, failure to install specified system components such as fire and smoke dampers, controls, etc., and failure to maintain the system properly. For example, if dampers aren't where they are supposed to be or if they are blocked open, they cannot perform their protective functions.

Many fire investigations have shown such system failures. An extreme example, of course, was the tragic fire in the MGM Grande Hotel in Las Vegas a few years ago.

Question 3 -- DOES THE USE OF SMOKE CONTROL SYSTEMS REDUCE THE NEED FOR FIRE-RATED WALLS AND CEILINGS OR THE NEED FOR FIRE DAMPERS IN DUCT SYSTEMS?

Answer -- No. The objective of an engineered smoke control system is to contain both the fire and its combustion products within a prescribed area. Fire dampers and smoke dampers -- some dampers perform both functions -- can prevent spread of the fire and combustion products through the duct system, but achieving this would be futile if fire were able to penetrate unprotected walls and ceilings. Fire-rated construction assemblies are, if anything, more important when a smoke control system is in use, there are better opportunities to contain both fire and smoke.

Senator RANDOLPH. Thank you very much, Mr. Gilkey.

I have no questions for you. As I say, there may be questions in writing, and we would appreciate it if you would respond to them.

Mr. GILKEY. We would welcome such questions, Senator.

Senator RANDOLPH. I think all of our witnesses today have given us information, expressed concern, and also have caused us to realize that it is a cooperative effort which is needed between governmental agencies at many levels and private industry, of course, throughout the country.

I go back to the statement I made before: Perhaps 30 percent nationwide of the loss from fires that you tell us ways we can handle, keep them from happening and then make them, let's say, the least death-dealing as possible when they have come into being, are caused by arson. Am I right about that? That is what my studies show, almost 30 percent of the financial loss from fires in West Virginia are due to arson. Maybe we are a violent people, you know. I want to sort of zero in on this subject.

Mr. GILKEY. Well, sir, SMACNA is not expert in this area, but surely these statistics do say that, and surely some of the major and most tragic fires have been started by arson. I particularly appreciated the discussion of this issue that others carried on this morning, about the need for enhancing the ability of the local fire departments to identify arson as a source of fires they previously might have thought to be accidental. This increases the ability of the local authorities to identify the arsonist himself, to identify the patterns in the community, and to deal with the situation.

Senator RANDOLPH. I personally know of a fire within the last 2 months in a certain community, a small apartment house. The fire was caused by a disagreement between two of the people who lived in the apartment. Just to carry that disagreement further, one of them apparently just set fire to the building so that the other man who was a semi-invalid, frankly, had no opportunity to escape.

The human race is a difficult subject matter. I have talked about it too much here today.

Senator Quayle is especially appreciative, Mr. Flucker, that you have come today. If you have a formal statement or comments that you would like to make—and you can identify yourself again—please proceed.

STATEMENT OF RONALD L. FLUCKER, MANAGER, CONSTRUCTION SERVICES, UNITED STATES STEEL, PITTSBURGH, PA., AND CHAIRMAN, AMERICAN IRON AND STEEL INSTITUTE COMMITTEE ON CONSTRUCTION CODES AND STANDARD, ACCOMPANIED BY RICHARD G. GEWAIN, CHIEF FIRE PROTECTION ENGINEER, AMERICAN IRON AND STEEL INSTITUTE

Mr. FLUCKER. Thank you. I do have a statement, Senator.

I will say that your statement about someone almost dying in a fire that was intentionally set reminds me of 4 years ago. My son almost had the same kind of an experience in college then when a lover's spat upstairs became a real fire, intentionally set and he was awakened by firemen at 7 o'clock in the morning in a smoke-filled room. It was almost a tragic situation.

I am Ron Flucker, appearing here today as chairman of the Committee on Construction Codes and Standards of the American Iron and Steel Institute, the trade association representing the basic manufacturers of steel. In 1938, AISI organized its building codes committee. It was directed then and is directed now to study building regulations as a primary interest and to undertake a variety of research studies and other activities, all of which are focused on the problem of providing sound and rational building code regulations, 75 percent of which relate to fire and fire protection matters.

Since then, thousands of research projects, tests, surveys, and other investigations have been conducted by AISI to supplement existing information in the field of fire protection, both with respect to the integrity of buildings and to life safety. This information is made freely accessible to anyone who serves on code-writing bodies or who may otherwise have an interest in better regulations for the building construction industry, as well as fire protection and building design professionals. Thus, the American Iron and Steel Institute provides a continuous flow of up-to-date code-related information for the building construction industry.

For example, one of the research programs sponsored by AISI, including our Canadian members, involved the testing of steel columns and the development of a solution for establishing fire protection guidelines for a wide variety of steel column sizes. These procedures are described in detail in an AISI publication, "Designing Fire Protection for Steel Columns." A similar design guide for steel beams is in preparation.

In addition to these guides, used mostly for commercial and industrial buildings, we have recently investigated the use of a so-called staggered truss system, a recent innovation used for residential occupancy-high rise, like hotels and apartments, and another new system used for hospitals called the interstitial truss system. It permits vast changes in hospital layout without massive costs. Both of these are covered in the AISI publication, "Designing Fire Protection for Steel Trusses."

For smaller, multiple-family residential occupancies like motels, apartments, nursing homes, and the like, where light-gage steel framing for both interior and exterior walls is being used, we ran comprehensive tests at Underwriters Lab and published a further design guide for fire ratings.

In recent years you may have noticed the increasing popularity of exposed steel in building construction. Sometimes the steel frame that supports the building is on the outside, and building code requirements for fire-resistant construction are paramount here since there is little or no fire protection material on these exposed members. Through extensive testing, this design method is now accepted, and AISI's "Design Guide for Fire-Safe Structural Steel" provides a detailed method for evaluating the safety of exterior structural steel members in fire exposure.

Related to this rational approach is AISI's current research, aimed at developing fire-resistant designs based on actual building conditions and the use of computers—as some others have mentioned here, and we are doing it—to model real structural systems as opposed to theoretical ones. After many years of research, AISI

developed a computer program to analyze a floor and building frame system when exposed to fire.

Called FASBUS, or Fire Analysis of Steel Building Systems, it was put to the test last year when we practiced arson on a 2-story steel frame test building. While the fire was proceeding, over 150 instruments measured temperatures and deflections in the building, built by AISI in cooperation with the National Bureau of Standards and the Institute of the Ironworking Industry, a labor-management group. The tests on the building matched the results predicted by the computer almost perfectly, another step toward a rational approach. This is an example, incidentally, of what Dr. Lyons said, "Industry is placing people in the National Bureau of Standards and we are developing information and test work." So this is a very specific example of that.

In another effort, one of the most valuable and promising research programs conducted by the steel industry in North America has been the long-term study of combustibility conducted by Dr. Edwin Smith at the Ohio State University. Started in 1967 and continuing today, the purpose of the project was to measure the fire hazard of materials in terms of the rate of heat release, smoke development, and toxic gas evolution. Among other offshoots of that research has been the Ohio State University release rate apparatus. To date, 50 of these ASTM standard testing units have been built and are in use worldwide.

What can you do with them? Using the OSU apparatus, Dr. Smith and his colleagues have been able to develop a computer program which will enable us to accurately predict the amount of heat from combustion of all materials in a given space, or in an entire building, and to calculate the rate of fire development and temperatures during the fire.

Another AISI research project still underway at Worcester Polytechnic Institute will utilize this concept in the design of buildings. A computer will evaluate the performance of different designs relative to the computer program from OSU, and we will be able to predict performance of buildings in actual fire situations.

Thus, we see the full circle of the rational or analytical approach to fire safety. This is the AISI program of the late eighties.

I have tried to give you a very brief overview of our activities. I hope it has convinced you of our abiding interest in fire and life safety related to fire. We stand willing and able to help this committee in any way that we can in your mission, and we welcome your interest.

Thank you.

[Responses of Mr. Flucker to questions submitted by Senator Hatch follow:]



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August 26, 1983

Hon. Orrin G. Hatch
Chairman
Committee on Labor and
Human Resources
United States Senate
Washington, DC 20510

Dear Senator Hatch:

Thank you very much for the opportunity to testify during your recent meeting on fire safety.

Attached are my comments as you requested in your letter of July 29.

Sincerely,

Ronald L. Flucker
Manager
Construction Services

RLF:mls

Attachment

August 26, 1983

R. L. Flucker's response to two questions submitted by Senator Orrin Hatch in his letter of July 29.

WHAT ARE THREE THINGS THAT COULD BE DONE THAT WOULD MOST REDUCE DEATHS BY FIRE?

Federal Emergency Management Administration (FEMA) and National Fire Protection Association (NFPA) records show that over four-fifths of the reported 6,700 civilian fire deaths result from fires in residential occupancies - two-thirds of the total occurred in one and two-family dwellings and most of the remainder from fires in apartments.

The principal reported causes of these fires in residential occupancies are heating equipment, first; and cooking activities, second. Smoking accounted for only eight percent of fires that resulted in deaths in all residential occupancies, but 29 percent in hotels and motels.

1) Since fire in homes is usually the result of carelessness or improper maintenance or use of fuel burning or electrical devices such as cooking equipment, the only practical response is education. Any educational program should have two principal objectives: instruction for proper use and care of these devices, and emergency preparedness for prompt escape in event of fire.

The national Fire Protection Association has long been a major factor in fire safety education and we endorse their objectives and programs in this field.

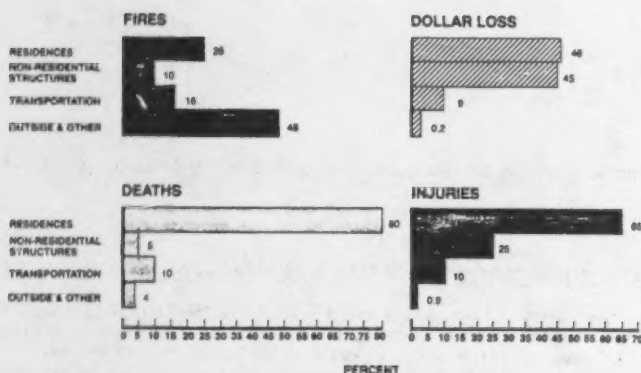
2) Smoking is a major cause of fires in hotels and motels. Education may not be enough, since, unfortunately, there may be too many innocent victims of smokers carelessness. Current building regulations have come a long way in requiring both smoke and fire alarm systems and automatic fire suppression systems in these occupancies and those measures could be given expanded application.

3) Smoke detectors seem to be one of the best methods of providing early alarm from fire in residential buildings. Modern building regulations now specify that new homes and residential buildings be equipped with smoke detectors that provide early warning by detecting products of combustion. A greater effort should be made to have the same type of products in existing buildings.

HOW DO YOU SUGGEST WE GO ABOUT INFORMING THE PUBLIC OF THE DANGERS OF FIRES IN ORDER TO REDUCE THE NUMBER OF DEATHS AND INJURY FROM FIRES?

AISI has long been concerned with structural fire safety and has encouraged the adoption by states and municipalities of building regulations that are directed towards minimizing the spread of fire and smoke in buildings. The intent and scope of this activity is described in AISI's book, "Fire Protection Through Modern Building Codes", now in its fifth edition. A copy is included with this response.

Beyond this, we feel that other entities are more qualified to respond to the question of identifying effective public educational techniques.



SOURCES: National Fire Incident Reporting System and National Fire Protection Association, National Center for Health Statistics, and the National Highway Traffic Safety Administration (adapted).

Figure 2. FEMA estimates of where 1981 fire losses occurred.

property losses from fire. (See Figure 2.) Nonresidential structural fires caused about 10 percent of the fire incidents, 5 percent of the deaths, 45 percent of the property losses, and 25 percent of the injuries.

It is estimated that there were 461,182 vehicle fires during 1981, accounting for roughly 16 percent of all fires. These vehicle fires caused an estimated 782 deaths, 3,130 injuries, and more than \$580,000 in property loss.

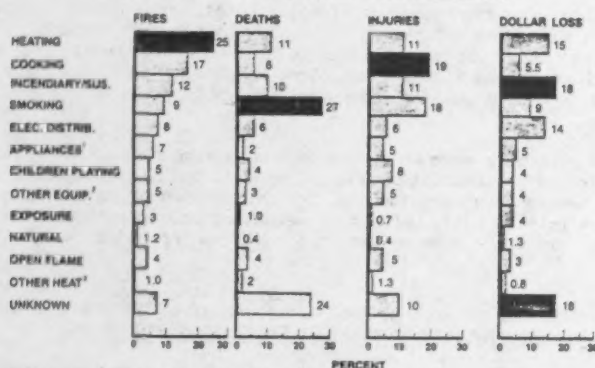
Outside fires (exclusive of vehicle fires) account for 48 percent of the fires, but claim only 4 percent of the fire deaths, less than 1 percent of the fire injuries, and 0.2

percent of the property losses from fire. These figures lend considerable support to the statement: "Many outside fires are small nuisance fires." Table 2 shows the 1981 national estimates for the four fire loss measures by type of occupancy.

Causes of 1981 Residential Fire Losses

The leading causes of residential fire losses vary somewhat by the four specific loss measures. (See Figure 3.) For residential fires, the four leading causes are heat-

Figure 3. FEMA estimates of the causes of 1981 residential fires.

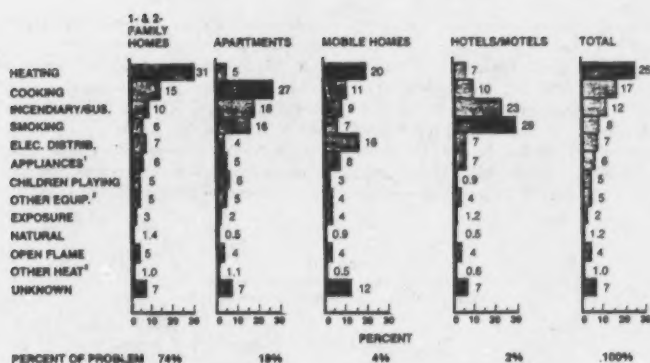


The estimates are based on NFIRS data.

¹ Includes all items listed as appliances in NFPA 901, along with air conditioners.

² Includes special equipment, processing equipment, and service or maintenance equipment.

³ Includes other remaining heat sources such as rekindled fire, fireworks, explosives, heat or spark from friction, molten or hot material, and other heat from a spark or hot object.



The estimates are based on NFIRS data.

¹ Includes all items listed as appliances in NFPA 901, along with air conditioners.

² Includes special equipment, processing equipment, and service or maintenance equipment.

³ Includes rekindled fire, fireworks, explosives, heat or spark from friction, molten or hot material, and other heat from a spark or hot object.

Figure 4. FEMA estimates of the causes of 1981 fires in residential occupancies.

For dwelling fires of known cause, 160,000 of the 522,000 fires, or 31 percent, were caused by heating. (See Table 3.) Cooking caused 76,000 fires or 15 percent of the one- and two-family dwelling fires, while the third leading cause of fires, incendiary/suspicious, claimed 52,000 or 10 percent of the dwelling fires. Electrical

distribution fires ranked as the fourth leading cause of dwelling fires, claiming 37,000 fires or 7 percent of the one- and two-family dwelling fires. Smoking is the leading cause of fatal dwelling fires.

Heating is not the leading cause of apartment fires, perhaps because many apartment heating systems re-

Table 3.
FEMA Estimates of 1981 Causes of Fires in Residential Occupancies
(Without Unknowns Allocated)

Cause	DWELLINGS		APARTMENTS		MOBILE HOMES		HOTELS/MOTELS		OTHER RESIDENTIAL		TOTAL	
	Number	Percent [†]	Number	Percent [†]	Number	Percent [†]	Number	Percent [†]	Number	Percent [†]	Number	Percent [†]
Heating	159,786	30.6	7,359	5.1	5,189	20.1	789	6.5	1,780	17.8	174,883	24.5
Cooking	75,715	14.5	39,393	27.3	2,803	10.9	1,263	10.4	970	9.7	120,144	16.8
Incendiary/ Suspicious	51,695	9.9	25,973	18.0	2,314	9.0	2,793	23.0	1,950	19.5	84,725	11.9
Smoking	29,764	5.7	22,799	15.8	1,749	6.8	3,546	29.2	1,140	11.4	58,998	8.3
Electrical												
Distribution	36,552	7.0	6,060	4.2	4,011	15.6	802	6.6	620	6.2	48,045	6.7
Appliances	30,808	5.9	6,638	4.6	2,031	7.9	802	6.6	490	4.8	40,769	5.7
Children Playing	24,020	4.6	8,225	5.7	883	3.2	109	0.9	270	2.7	33,447	4.7
Other Equipment	27,153	5.2	6,782	4.7	1,106	4.3	496	4.1	280	2.6	35,819	5.0
Exposure	13,054	2.5	3,030	2.1	1,029	4.0	146	1.2	210	2.1	17,469	2.4
Natural	7,311	1.4	721	0.5	231	0.9	61	0.5	90	0.9	8,414	1.2
Open Flame, Heat	23,408	4.5	5,916	4.1	1,131	4.4	473	3.9	580	5.8	31,596	4.4
Other Flame, Heat	5,222	1.0	1,587	1.1	129	0.5	75	0.6	130	1.3	7,141	1.0
Unknown	37,597	7.2	9,812	6.8	3,189	12.4	789	6.5	1,501	15.0	52,888	7.4
TOTAL ^{††}	522,175	100.0	144,295	100.0	25,715	100.0	12,144	100.0	10,001	100.0	714,330	100.0

Based on FEMA analysis of NFPA's 1981 National Fire Experience Survey.

[†] Based on 1981 NFIRS data, including 156,315 residential fires. Dwelling fires accounted for 116,387 fires, apartments accounted for 28,999 fires, mobile homes accounted for 3,769 fires, hotels and motels accounted for 2,747 fires, and other residential occupancies accounted for 2,428 fires.

^{††} Based on FEMA analysis of NFPA's 1981 National Fire Experience Survey, except for mobile homes.

last year, and 970 occurred in apartment fires, a decrease of 5.4 percent from last year.

In 1981, 770 civilian fire deaths were caused by highway vehicle fires, an increase of 18.5 percent from a year ago. (The estimate of civilian deaths in vehicle fires could have been considerably higher had it not been for verification efforts that are discussed in the Data Collection and Estimation Methodology sections of this report under "How the Survey Was Conducted.") Fires in nonresiden-

tial structures accounted for 220 civilian deaths in 1981, a decrease of 3.9 percent from 1980.

Of all specific properties, residences continue to account for the most civilian fire deaths (82.7 percent in 1981) and should continue to be the target of firesafety education efforts.

The NFPA estimates that 820 or 14.2 percent of all civilian deaths that occurred in structure fires in 1981 were caused by fires of an incendiary or suspicious na-

Table 1.
Estimates of Total 1981 United States Fires,
Civilian Deaths, Civilian Injuries, and Property Loss

	Estimate	Range ¹	Percent Change from 1980
Number of Fires	2,893,500	2,839,500 to 2,947,500	-3.5†
Number of Civilian Deaths	6,700	6,500 to 7,200	+3.0
Number of Civilian Injuries	30,450	28,500 to 32,350	+0.8
Property Loss ²	\$6,676,000,000	\$6,346,000,000 to \$7,006,000,000	+6.7

The estimates are based primarily on data reported to the NFPA by fire departments that responded to the 1981 National Fire Experience Survey; adjustments were made based on data reported to the NFPA in the FIDO (Fire Incident Data Organization) System.

¹ 95 percent confidence interval.

² Includes overall direct property loss (loss to contents, structure, a vehicle, machinery, vegetation or anything else involved in a fire) and does not include indirect losses, e.g., business interruption or temporary shelter costs; no adjustment was made for inflation in the year-to-year comparison.

† Change was statistically significant at the .05 level.

Table 2.
Estimates of 1981 United States Civilian Fire Deaths
and Injuries for Selected Property-Use Categories

Property Use	Civilian Deaths			Civilian Injuries		
	Estimate	Percent Change from 1980	Percent of all Civilian Deaths	Estimate	Percent Change from 1980	Percent of all Civilian Injuries
Residential (total)	5,540	+1.7	82.7	20,375	-3.4	67.0
One- and Two-Family Dwellings ³	4,430	+6.1	66.1	14,875	-7.6	45.9
Apartments	970	-5.4	14.5	4,250	+14.1	14.0
Hotels and Motels	90	-45.5	1.4	550	-20.9†	2.5
Other Residential	50	-34.2	.7	400	+23.1	1.3
Non-Residential Structures ⁴	220	-3.9	3.3	5,325	+46.9††	17.5
Highway Vehicles	770	+18.5	11.5	2,900	+1.8	9.5
Other Vehicles ⁵	70	-22.2	1.0	500	-59.2	1.6
All Other Categories ⁶	100	+13.6	1.5	1,350	-3.6	4.4
	6,700	+3.0		30,450	+0.8	

Estimates are based primarily on data reported to the NFPA by fire departments that responded to the 1981 National Fire Experience Survey; some of the estimates are based on data reported to the NFPA in the FIDO (Fire Incident Data Organization) System.

¹ Includes mobile homes.

² Includes public assembly, educational, institutional, stores and offices, industry, utility, storage, and special structure properties.

³ Includes trains, boats, ships, aircraft, farm vehicles and construction vehicles.

⁴ Includes outside properties with value, brush, rubbish, and other.

† Change was statistically significant at the .05 level.

†† Change was statistically significant at the .01 level.

Senator RANDOLPH. Thank you very much, Mr. Flucker.

For Senator Hatch, our chairman, and all members of the committee, I would announce that at the present time apparently there are no hearings scheduled, at least in the near future. This hearing is the basic hearing which will permit us—and also with the aid of our staff on the committee and our personal staff—to go into this testimony very thoroughly. From this first meeting there will be, perhaps, other meetings that may be arranged.

I do not pass a pleasantry when I say to those that are now testifying and all those that have spoken earlier today, that I have been mindful of the ingenuity and the expertise which goes into the construction of materials and those facets of the fire problem which occurs, as well as the attention, devotion, and valor of those who fight against those fires that come into being throughout America. I know of many of those instances, as do all who are in this room today.

I think that we have an obligation now to act where perhaps we have not acted before. I am sure that is shared in large degree by the chairman of our committee.

Again, I want to thank all the witnesses who have testified. There will possibly be questions asked of you that are not asked by members who were here, or those who are interested who could not be here this morning. We thank you very much.

Let's keep in our minds the obligation as individuals, those of you who represent organizations, yes, but just Mr. and Mrs. America per se have tremendous responsibility in an individual way to take the information you have given and to hopefully make this a country not with the record which is so bad, as Senator Quayle has indicated, from the standpoint of the structures that are brought into being and the materials that are used and even the actions of people that cause the problems in this area.

Thank you very much.

[Whereupon, at 11:55 a.m., the committee recessed, to reconvene at the call of the Chair.]